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INSTRUCTION MANUAL

MODEL 61A1A
MICROWAVE RECEIVER

PRECISION MICROWAVE AND RF TEST EQUIPMENT
THE NARDA MICROWAVE CORPORATION, PLAINVIEW, L.I., N.Y. 11803 • 516 GE 3-9000

THE NARDA MICROWAVE CORPORATION

TECHNICAL MANUAL
OPERATING AND MAINTENANCE INSTRUCTIONS

FOR

MODEL 61A1A
MICROWAVE RECEIVER

TM2-67021-61A1A

February, 1967

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A.

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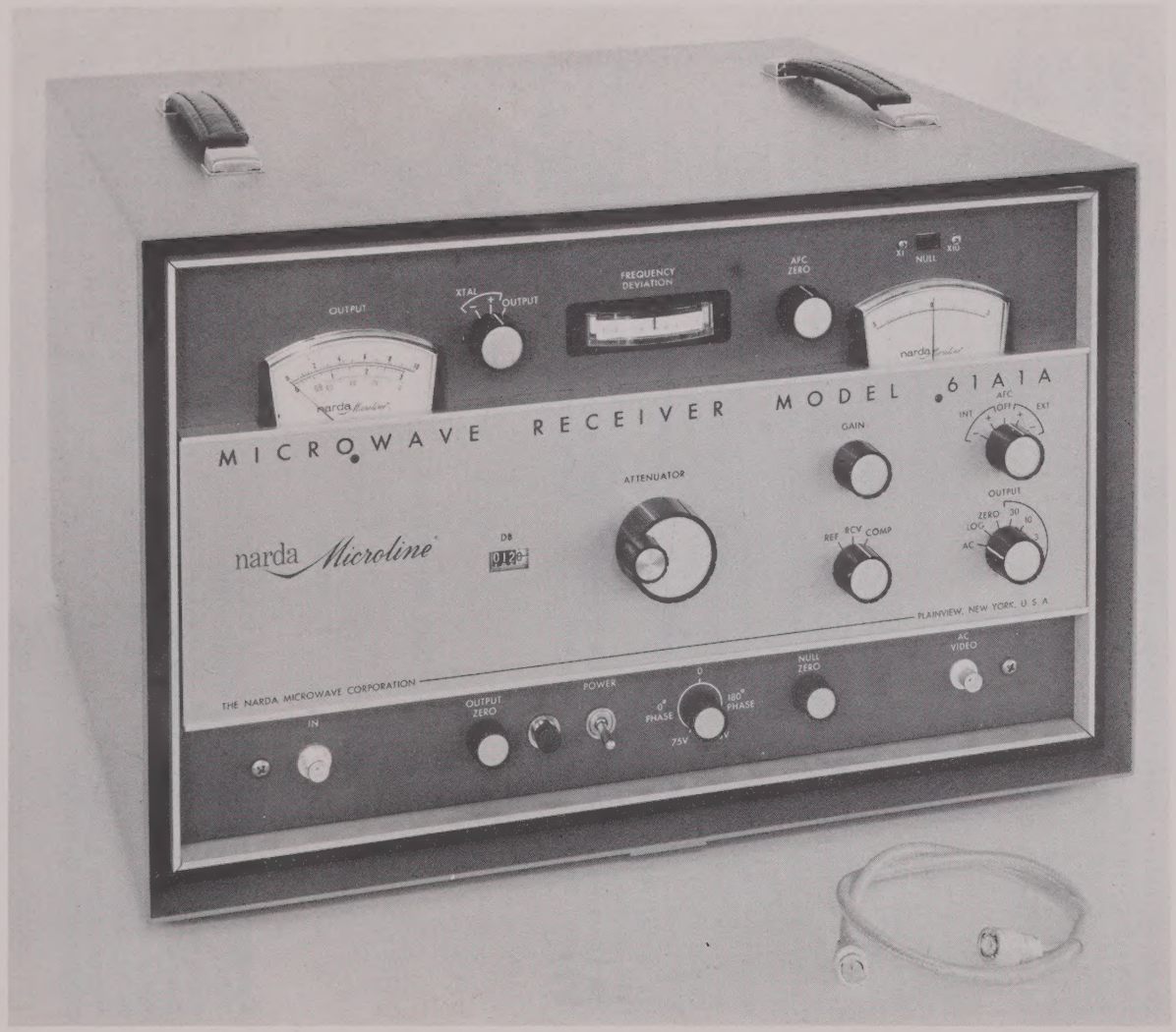


Figure 1-1. Narda Microline Model 61A1A Microwave Receiver

Section I
General Description

1-1. INTRODUCTION

1-2. This manual contains instructions for the use and maintenance of the Narda Microline Model 61A1A Microwave Receiver designed and manufactured by the Narda Microwave Corporation, Plainview, L.I., New York. The manual includes a general description of the equipment, installation and operating instructions, theory of operation, maintenance data and a replaceable parts list.

1-3. PURPOSE AND USE OF EQUIPMENT

1-4. The Narda Microline Model 61A1A Microwave Receiver (figure 1-1), hereinafter referred to as the Receiver, is a unique and versatile instrument which, in conjunction with standard waveguide and coaxial instruments, is capable of performing highly accurate attenuation and power measurements, and can also be used as a calibration source for signal generators; attenuation measurements of 100 db or more in a single step and absolute power measurements at levels as low as -80 dbm are possible. Power levels as low as -110 dbm are possible where the signal is capable of being 100%-modulated with the squarewave generated by the internal attenuation calibrator.

1-5. In addition, the Receiver may be used as a conventional lin-log receiver over the extremely wide frequency range of 10 MHz to 40 GHz by the use of standard, readily-available waveguide and coaxial components, and single-ended crystal mixers such as the Narda Microline 34( )1 series of Tunable Detector-Mixer Mounts. For antenna measurements, a 60-db log scale and recorder output are provided. In conventional linear operation, the unit can be used as an extremely sensitive microwave detector.

1-6. EQUIPMENT SPECIFICATIONS

1-7. Table 1-1 provides a listing of pertinent electrical and mechanical specifications of the Receiver.

Table 1-1. Equipment Specifications

Frequency Range . . . . . 10 MHz to 40 GHz

Input Frequency . . . . . 30 MHz

Accuracy: . . . . . Single Step . . . . . .

Attenuation (db)	Max Error (db)	Attenuation (db)	Max Error (db)
10	±0.06	60	±0.25
20	±0.08	70	±0.30*
30	±0.10	80	±0.35*
40	±0.15	90	±0.40*
50	±0.20	100	±0.50*

10 db Increments . . . . . .

Input Level to Mixer	Maximum Error
-10 to -25 dbm	±0.12 db/10 db
-25 to -80 dbm	±0.06 db/10 db
-80 to -95 dbm	±0.12 db/10 db*
-95 to -110 dbm	±0.20 db/10 db*

Null Resolution: . . . . . 0.008 db/division to -95 dbm (NULL switch in X1 position)
0.08 db/division to -95 dbm (NULL switch in X10 position)
0.05 db/division to -110 dbm (NULL switch in X1 position)
0.5 db/division to -110 dbm (NULL switch in X10 position)

*Microwave signal source externally modulated by Receiver.

Table 1-1. Equipment Specifications (continued)

I-F Amplifier:	
Center Frequency	30 MHz
Bandwidth	1.0 MHz
Output	0 to 30 volts, linear to 3%; 60 db log (0 to 30-volt range) to 3%; AGC, 2 volts out (approximately)
Overall Effective Noise Figure	3 db or better (including input switch)
Gain Variation	In excess of 65 db
Reference Oscillator:	
Frequency	30 MHz ±0.02%, crystal controlled
Amplifier Stability	0.005 db/10 minutes
Comparison Setup:	
Switching Rate	1 KHz
Signal Switching	Internal or external; 1 KHz squarewave output, 75 volts peak-to-peak, 0 degrees or 180 degrees
30 MHz Attenuator:	
Attenuation	0 to 100 db indication with in-line readout (0.02 db least division)
Insertion Loss	"Zero" insertion loss approximately 23 db
Accuracy	0.05 db/10 db; 0.10 db maximum
Outputs	AC video on front panel DC video on rear panel Recorder output, 0 to 1 ma, 1500 ohms, one side ground 30 MHz output from reference oscillator on rear panel
Output Level Indicator:	
DC Video Ranges	1, 3, 10 and 30 volts full scale
Log DC Video	0 to 60 db range, 20 volts full scale
AC Video	10 volts full scale
Mixer Crystal Current	3 ma full scale, positive or negative polarity
Frequency Deviation Indicator	Center zero; approximately ±150 KHz full scale depending on loop gain adjustment
Null Indicator	Center zero; (See null resolution spec)
AFC Unit:	
Correction Voltage Range	±25 volts centered on input reflector voltage
Control Current	0 to 20 ma either polarity
Sense	Selected + or - from panel
Insulation	5000 volts for beam plus reflector
Center Frequency	Locked to reference oscillator frequency for comparison mode; Locked to discriminator center frequency for standard receiver mode
Loop Gain	Adjustable by rear panel control
Power	105 to 125/210 to 250 volts, 50 to 60 Hz line; approximately 150 watts
Weight	55 pounds, including case
Size	12 1/2"W x 18"H x 19"D; 10 1/2" rack mount panel

1-8. EQUIPMENT SUPPLIED

1-9. In addition to the integral line power cable, a 2-foot video cable (figure 1-1) is supplied; this cable contains a TNC male connector at one end for connection to the Receiver front panel IN jack and a BNC female connector at the other end for connection to the video output source. Optional accessories for the Receiver include a 50 to 100-ohm matching transformer, Narda Model 61A1-31 and a 100-ohm output-to-variable 200 to 600-ohm input matching transformer, Narda Model 61A1-34. These accessories permit matching of specific mixers directly to the 100-ohm input impedance of the Receiver.

1-10. PRINCIPLES OF OPERATION

1-11. The Receiver is designed for use with standard waveguide and coaxial components and single-ended mixers similar to the Narda Microline 34( )1 Tuneable Detector-Mixer Mounts. The microwave test signal and the local oscillator signal are combined in a linear response mixer to produce a 30 MHz i-f output which varies with changes in the level of the microwave test signal. The i-f test signal is 100% amplitude-modulated either by the diode switch or by modulating the microwave signal source. The latter technique is desireable to achieve the full dynamic range of the Receiver. The modulated i-f test signal is combined with the parallel 30 MHz reference signal at the input to the i-f amplifier. An ultra-stable, crystal-controlled oscillator generates the 30 MHz reference signal which is amplitude-modulated 180 degrees out of phase with the test signal. The level of the reference signal is accurately controlled by a 30 MHz standard attenuator. In effect, the i-f amplifier input is switched alternately between the i-f test signal and the 30 MHz reference signal at a 1 KHz rate.

1-12. The i-f amplifier, 1 KHz amplifier and phase detector function as a null indicating system which monitors equality by noting the standard attenuator readings for null indication before and after the level of the microwave signal is changed by insertion of the unknown. For making power measurements, an absolute power calibration is obtained by using an accurately known microwave signal power (e.g., 1 millivolt) in setting the initial reference null. The effect of frequency drift of the microwave signal generator or local oscillator on measurement accuracy is minimized by high performance AFC circuitry. Signal generators are sometimes used in attenuation measurements; their inherent frequency stability usually must be better than individual sources since they generally do not have provisions for AFC.

1-13. The chief advantage of the parallel i-f substitution technique is that a greater dynamic range is obtained, because much smaller signal powers can be utilized. In a series substitution system, the minimum useful signal power is limited by the insertion loss in the 30 MHz standard attenuator. If a preamplifier is used to compensate for this insertion loss, the dynamic range is further limited to the linear range of the preamplifier (typically 40 db for a 0.1 db accuracy). Parallel substitution imposes none of these limitations on minimum detectable signal and, in fact, the coherent phase detector provides an additional improvement in usable signal-to-noise ratio.

1-14. SEMICONDUCTOR TUBE, FUSE AND LAMP COMPLEMENTS

1-15. Table 1-2 provides a listing of the transistor, tube and diode complement of the Receiver; table 1-3 lists the fuse and lamp complement.

Table 1-2. Tube, Transistor and Diode Complement

Ref. Designation	Type	Quantity
V1, V2	OA2	2
V101	6AW8	1
V201	6BX7	1
V202, V504	12AX7	2
V203	OB2	1
V301	6U8	1
V302	12AT7	1
V303, V505	12AU7	2
V304, V401, V501, V502	6DJ8	4
V402, V403	6EH7	2
V404	6EJ7	1
V405	6BH6	1
V406	6AL5	1
V503	6C4	1
V506	6AR8	1
Q1, Q2	2N176	2
Q3	2N1381	1
Q4	2N1363	1
Q301	2N388A	1
Q501	2N398A	1
CR1 thru CR8, CR11 thru CR16	CER-71	25
CR17, CR201 thru CR206, CR303 thru CR307	1.5 M11Z	1
CR308	1N715	1
CR9, CR10	1N3208	2
CR101, CR701, CR702	1N270	3
CR301, CR302, CR401, CR402, CR501 thru CR503	1N67A	7

Table 1-3. Fuse and Lamp Complement

Ref. Designation	Type	Quantity
DS1, DS501	NE-2A	2
DS601	Neon	1
F601	2 Amp, 125V	1

Section II
Installation and Operation

2-1. GENERAL

2-2. The Receiver is shipped complete and ready to operate; no special installation procedures are required unless a fixed station or system type of installation is contemplated.

2-3. UNPACKING THE EQUIPMENT

2-4. Upon receipt of the Receiver, perform a preliminary visual inspection of the carton for evidence of damage during transportation. Any evidence of serious damage should be reported to the carrier prior to unpacking the equipment.

NOTE

Retain the shipping container for reuse, if later reshipment is anticipated.

2-5. If there is no evidence of damage, unpack the equipment, following conventional unpacking procedures and using care.

2-6. PRELIMINARY INSPECTION

2-7. The Receiver was tested and inspected at the factory before shipment. Immediately after unpacking the equipment visually inspect it for damage which may have occurred in transit, such as broken knobs, scratches on panels, damaged meters, etc. If there is any evidence of damage, immediately file a claim for damage in transit with the carrier. Refer to paragraph 2-55 for general instructions on packing for reshipment.

2-8. INSTALLATION

2-9. The Receiver is supplied with power supplies connected for 105-125-volt operation. If 210-250-volt operation is desired, jumper connections in the power supply must be changed according to the schematic in Section IV.

2-10. GENERAL. When the Receiver is operated in the bench cabinet supplied, leave 5 inches or more clearance at the rear for ventilation; do not obstruct the ventilating holes in the bottom of the case. The unit may be rack-mounted directly by removing it from the case. The panel is 10-1/2 inches wide and is notched for standard rack mounting.

WARNING

When operating the Receiver outside its case, remember that the AFC deck operates at the associated klystron circuit reflector potential. Precautions should be taken to prevent injury to personnel when operating the equipment in this manner.

2-11. REMOVING EQUIPMENT FROM CASE. To remove the unit from the case, proceed as follows:

a. Remove four screws securing trim angles on each side of front panel.
b. Loosen captive screw at rear of chassis and slide unit forward out of case.
c. To install the unit in the case, reverse steps a and b.

NOTE

The trim angles are mounted to the case by floating self-locking nuts to permit adjustment; top and bottom trim tees are also mounted on floating nuts. Since it is not necessary to remove the tees to take the unit out of the case, it is seldom necessary to disturb their factory adjustment.

2-12. OPERATION

2-13. The following paragraphs outline methods of use of the Receiver. These include the functions of operating controls, indicators and connectors; a typical test setup and precautions to be observed; preliminary adjustments required; and typical measurement problems.

2-14. FUNCTIONS OF OPERATING CONTROLS, INDICATORS AND CONNECTORS. Operating controls, indicators and connectors of the Receiver are shown in figure 2-1 and their functions are listed in table 2-1.

Table 2-1. Functions of Operating Controls, Indicators and Connectors

Figure 2-1 Index No.	Control, Indicator or Connector	Function
1.	OUTPUT meter	Indicates mixer crystal current, output VTVM reading or AGC control voltage.
2.	XTAL-OUTPUT switch	Selects polarity of crystal current reading (+ or -) or output function (VTVM or AGC) on OUTPUT meter.
3.	FREQUENCY DEVIATION meter	Indicates correction voltage on AFC which corresponds to frequency deviation in input signal.
4.	AFC ZERO control	Provides zero adjustment for phase modulator in AFC amplifier.
5.	NULL meter	Indicates null balance in comparison mode.
6.	X1-X10 switch	Slide switch selects null sensitivity for NULL meter for most convenient measurement. In X10 position sensitivity is reduced 10 times.
7.	GAIN control	Adjusts gain of i-f strip in linear and a-c operation.
8.	AFC switch	A five-position switch for selection of INT (- or +) or EXT (+ or -) AFC voltage; in center position (OFF), AFC is disabled.
9.	REF-RCV-COMP switch	Three-position switch for selection of reference oscillator, straight receiver or comparison operation.
10.	OUTPUT select switch	Selects linear (1, 3, 10 or 30), LOG or AC indication on OUTPUT meter; ZERO position may also be selected.
11.	AC VIDEO jack	A BNC female connector supplying a-c video output from i-f strip cathode follower.
12.	NULL ZERO control	Provides electrical zero adjustment for NULL meter.
13.	1 KHz EXT MOD control	Adjusts amplitude (75V) and phase (0° PHASE or 180° PHASE) of 1 KHz external modulation square-wave.
14.	POWER switch	Two-position toggle switch to control application of a-c power to Receiver.
15.	Power Indicator	Illuminates when a-c power is applied to Receiver.
16.	OUTPUT ZERO control	Provides electrical zero adjustment for OUTPUT meter.
17.	IN jack	A TNC female connector for 30 MHz input to Receiver.
18.	DB readout	Indicates relative db setting of ATTENUATOR control.
19.	ATTENUATOR control	Controls attenuation setting of 30 MHz i-f attenuator; relative attenuation appears in DB readout window.
20.	30 MHz OUTPUT jack	A BNC female connector supplying approximately 1.7 volts output from 30 MHz reference osillator.
21.	1 KHz OUT jack	A BNC female connector supplying a 1 KHz square-wave output for scope sync and external switching.
22.	EXT AFC jack	A BNC female connector for input of an external source AFC control signal.
23.	RECORDER jack	An output phone jack supplying 1 ma for 1500-ohm graphic recorder, one side ground; connected in VTVM for OUTPUT meter. Recorder current not affected by switching OUTPUT meter to XTAL function.
24.	DC VIDEO OUTPUT jack	A BNC female connector supplying the video output from i-f strip video detector.
25.	SWITCHING/INT-EXT switch	A three position (center position off) toggle switch for selection of internal or external switching mode.
26.	KLYSTRON POWER INPUT connector	A six-pin connector for associated klystron power supply input.
27.	KLYSTRON POWER connector	A six-pin connector for supplying AFC corrected voltage to associated klystron.

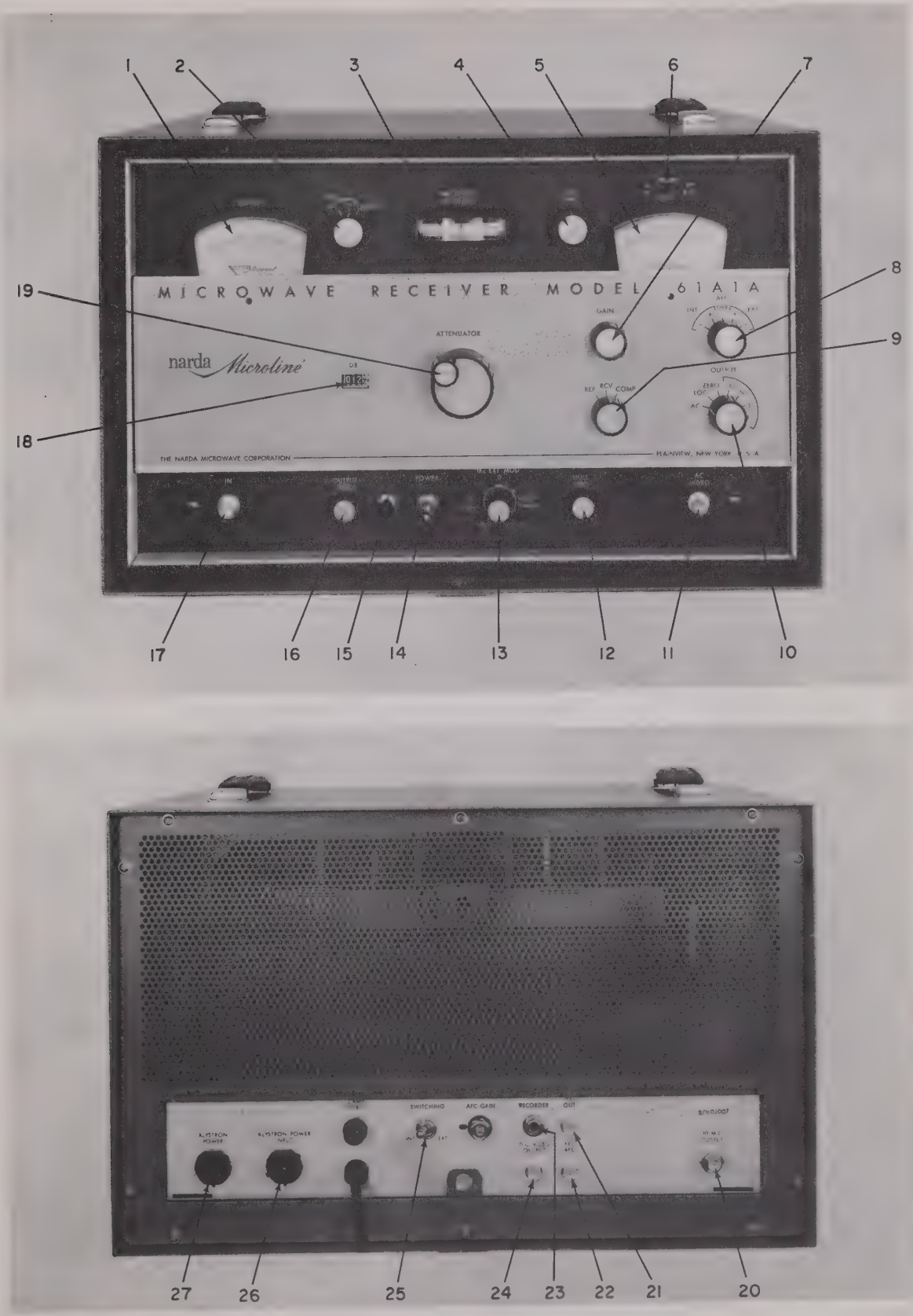


Figure 2-1. Operating Controls, Indicators and Connectors

2-15. TYPICAL MEASUREMENT SETUP. (See figure 2-2.) A typical setup using the Receiver for attenuation measurement is shown in figure 2-2. External signal switching is shown. The only change in the setup for internal switching would be the omission of the 1 KHz signal cable between the Receiver and the Narda Microline 62A1A Universal Klystron Power Supply. The oscilloscope is not absolutely essential but is an extremely valuable accessory in this or any microwave setup. Oscilloscope external sync may be obtained from the 1 KHz signal used to modulate the signal klystron.

2-16. Electronic Units. The Narda Microline 62A1A Universal Klystron Power Supply furnishes beam, grid, and reflector voltages for the signal and local oscillator klystrons. Signal klystron modulation is obtained from the 62A1A modulator. Regulated filament power from the Narda Microline 62A2 DC Klystron Filament Supply contributes significantly in reducing frequency variations and incidental FM from the klystrons. The Narda Microline 62D1 Dual Klystron Adapter permits independent control of grid and reflector voltages for the two klystrons. A 1 KHz squarewave for signal modulation is supplied to the 62A1A from the Receiver. Local oscillator klystron power is connected to the Receiver from the dual adapter for insertion of AFC correction voltage; the local oscillator is then connected to the Receiver. Oscilloscope monitoring of the Receiver video output is helpful in adjustments and measurements.

2-17. Waveguide Components. The waveguide portion of the setup consists of a signal klystron, level-set attenuator, isolator, and slide-screw tuner, all of which may be considered as the source. The slide-screw tuner is used to tune the source group of components for Z_o, or minimum SWR. The unknown is inserted between the source group and the detector group. A slide-screw tuner and isolator are used following the unknown to tune the entire detector group of components for a match. Having a match in both directions from the unknown, insures measurement of the true attenuation of the unknown, including its mismatch losses.

2-18. Following the tuner and isolator in the detector group is a directional coupler with the LO klystron and its level-set attenuator on the side arm. Next is a frequency meter, followed by a tuner and detector mount used as a mixer. The last tuner is required since mixers are generally poorly matched to the line and additional tuning is necessary.

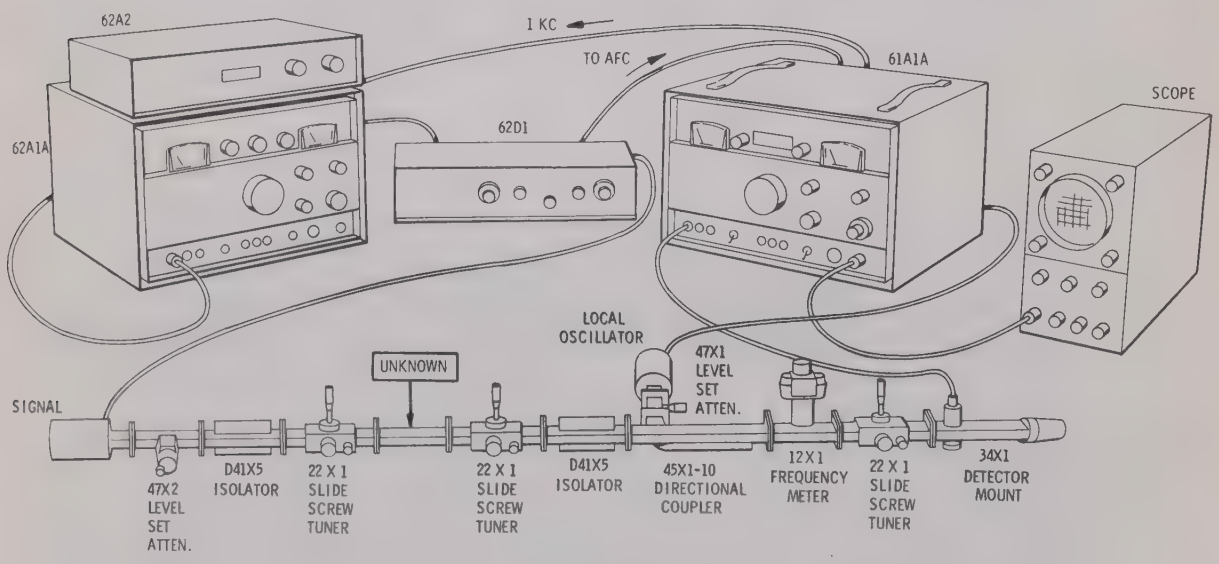


Figure 2-2. Typical Receiver Measurement Setup.

2-19. Precautions in Attenuation Measurements. A number of precautions are necessary in attenuation measurements if accurate and repeatable results are to be obtained. This is especially true with the Receiver because of its high resolution.

2-20. The waveguide setup must be mechanically stable. Flexing or bending of the setup or components in it will cause variations in tuning and attenuation in all or part of the setup. Flanges must be straight and clean to insure good r-f continuity and minimize leakage. Critical adjustments, such as on the tuners, must have locks to prevent accidential variation. The setup must be evenly supported to eliminate mechanical strain on components and flanges. Microwave reflective surfaces in the vicinity of the setup should be avoided since such surfaces will enhance the return to the setup of any leakage which may occur.

2-21. When performing measurements in some microwave setups it may be necessary to shield the klystron cables to prevent external noise pickup. Such noise pickup may increase the Receiver noise level to an extent sufficient to degrade the accuracy of low level measurements.

2-22. Tuning is very important for precise measurements. Receiver resolution is 0.01 db and mismatch errors in the setup can exceed this very easily. Time spent in matching the setup properly is well spent if accurate measurements are to be made conveniently.

2-23. Sometimes a small amount of backlash may be encountered in an attenuator. To minimize the affects of this backlash, approach the final attenuator setting from the same direction each time a new setting is made.

2-24. When performing measurements under poor signal-to-noise ratio conditions, local oscillator tuning should be made carefully. Under these conditions the signal deviation tends to be masked by the noise, causing AFC operation to be less sensitive (net discriminator output is lower for a given signal change). To minimize errors in measurement, it is necessary to tune the LO frequency as close as possible before switching to AFC operation.

2-25. If the unknown is a device with fixed attenuation, the setup must be adjusted to a reference level before it is inserted. After the reference is set, the setup must be handled carefully when putting the unknown into place to avoid changing the original conditions. It may be necessary to make such a measurement several times to eliminate variations due to flange misalignment, mechanical disturbances, and minor power fluctuations. Obviously, a stable signal source is essential in any attenuation measurement.

2-26. Klystron Considerations. For maximum operational efficiency in attenuation measurements, it is essential that stable signal sources be used. The best source from an overall standpoint is a klystron. Under the proper operating conditions, klystrons generally have less incidental FM, better frequency and amplitude stability, and more power output than any other type of source. Some of the considerations in establishing these conditions are discussed in the following paragraphs.

2-27. Klystrons must be operated so the desired frequency falls in the center of the mode. Frequency and amplitude changes, with variations and ripple in the tube supply voltages, are minimum at this operating point. Although the Receiver AFC control provides a wide range of correction voltage, errors will be smaller and results will be more nearly repeatable if the correction required is minimized. It is important that both signal and LO sources be adjusted for their proper operating conditions and AFC used as insurance. This is particularly important if measurements are being made at very low signal levels (below about -90 dbm) where there will be some uncertainty in AFC and null circuits due to noise.

2-28. Many klystrons are sensitive to physical vibration. The setup must be mounted on a solid base and supported firmly to eliminate physical shocks to the klystrons. Vibration problems may arise from the method of cooling used on the tubes. It is important that tube temperature be stabilized as much as possible. High velocity blowers frequently used with klystrons generate a surprising amount of FM and vibration "noise" in the klystron output, even when they are separated from the tube by a flexible hose. Oil bath stabilization is much better than forced air. The most efficient cooling technique now in use is a water jacket in contact with the tube cavity. Water jackets not only give excellent temperature stabilization, but are completely free of vibration. Water jackets are available for many klystron types in the Narda Microline Klystron Kooler line.

2-29. The importance of setup tuning has already been mentioned, but its effect on klystron performance should also be noted. Frequently klystrons will become unstable when presented with a mismatched load. With the setup shown in figure 2-2, there will usually be enough attenuation inserted in the level set attenuator to present a good match to the klystron. Except in very unusual circumstances, there will probably not be any problems in an attenuation setup with poor matches at the klystron; however, the problem should be appreciated.

2-30. If internal switching is used in the Receiver the signal klystron operates continuously. If external switching is used, the signal klystron is squarewave modulated. Modulation amplitude and reflector voltage must be adjusted for clean, stable klystron output. The klystron must be adjusted so the desired frequency falls in the mode center before modulation is applied. Subsequent modulation adjustment will bring the output back to the most stable operating point when proper operating conditions are reached.

2-31. Mixer Considerations. The entire range of the Receiver can be covered using good single-ended mixers. Output traps are used in all Narda Microline detector mounts and excellent mixer performance is obtained with the resulting low capacity. If any other manufacturer's mount is used, it should be checked to be sure it is a low capacity type, or conversion loss will be excessive.

2-32. Some mixer crystal types will show a considerable range of conversion loss and noise figure. If difficulty is experienced in low level measurements, several mixer crystals should be tried. The average crystal is satisfactory for full range measurements, but it is not unusual to find one which gives marginal mixer performance.

2-33. Measurement range can be extended slightly on the upper end by increasing the local oscillator level, and on the lower end by decreasing the local oscillator level. The total measurement range (100 db) will remain the same, only the ends are shifted one direction or the other. Note that the local oscillator level increase is limited by crystal burnout and the decrease is limited by the measurement errors which can be tolerated.

2-34. The Receiver range, with respect to the mixer input power level, shifts with conversion loss. If the upper end of the range is fixed by the local oscillator level, poor mixer noise figure may prevent realization of the full 100-db range because the low levels cannot be reached.

2-35. Certain mixers may provide outputs which do not match the absolute level output range of the attenuator. The reference channel of the Receiver is designed for a specific input voltage range, not a power level. For a 100-db power range at the mixer input, an exceptionally good mixer may provide an i-f signal range above the Receiver range. In this case the i-f range is 100 db, but it may not coincide with the attenuator range.

2-36. INTERCONNECTION OF EQUIPMENT. (See figure 2-2.) The 62A1A and 62A2 are connected for DC filament operation and the output is connected to the 62D1 input. One output from the 62D1 is connected to the signal klystron and the other to the KLYSTRON POWER INPUT socket on the Receiver rear panel. Local oscillator klystron power is obtained from the KLYSTRON POWER jack on the Receiver rear panel. This connection inserts the Receiver AFC adapter into the local oscillator supply.

2-37. If external switching is used, the SWITCHING selector on the rear panel is set to EXT and a connection is made from the 1 KHz OUT jack to the EXT MOD jack on the 62A1A. This applies a 0 to 15-volt, 0° or 180° phase peak-to-peak 1 KHz square wave to the 62A1A modulator input and the EXT or AMPL EXT output will furnish ample modulating voltage for the klystron. If internal switching is used, the signal klystron is operated CW and this connection is omitted. The SWITCHING selector on the Receiver rear panel is set to INT for internal switching operation.

2-38. A dual shielded cable is supplied with the Receiver for connection between the mixer and the input jack. The Receiver is tuned for use with this cable and a low-capacity mixer such as the Narda Microline series. If another cable is used, it must be of a dual-shielded type since leakage or pickup in the input cable will introduce errors into the measurement, particularly at low levels. Use of cables having different capacity from the one supplied will detune the input circuits slightly. There will be little noticeable effect on performance, however, except at very low signal levels.

2-39. The signal for oscilloscope monitoring is available at the AC VIDEO jack on the Receiver front panel. For convenience, it is recommended that the signal from the 1 KHz OUT jack on the rear panel be used for oscilloscope external sync.

2-40. PREOPERATIONAL ADJUSTMENTS. (See figure 2-1). A warmup period of about 15 minutes is advisable before operating the Receiver. After warmup, the preoperational adjustments in paragraphs 2-41 through 2-43 should be made. These adjustments are outlined for internal switching; special considerations for external switching are outlined in paragraphs 2-44 and 2-45.

2-41. Preliminary Frequency Adjustment. Perform the preliminary frequency adjustment as follows:

a. Set XTAL-OUTPUT switch to OUTPUT position and set OUTPUT switch to ZERO position; adjust OUTPUT ZERO control for zero indication on OUTPUT meter.

b. Set NULL meter switch to X1 position and rotate AFC GAIN potentiometer on rear panel to maximum cw position.

c. Set REF-RCV-COMP switch to either REF or RCV position and adjust NULL ZERO control for zero indication on NULL meter.

d. Set REF-RCV-COMP switch to COMP position and set AFC switch to EXT position (+ or -). Check FREQUENCY DEVIATION meter for zero indication.

e. Set REF-RCV-COMP switch to RCV and adjust AFC ZERO control for zero indication on FREQUENCY DEVIATION meter.

2-42. Klystron frequencies should now be set. A frequency meter should be used to insure that the frequency difference between tubes is actually 30 MHz. A 30 MHz i-f strip will respond to sub-multiples of 30 MHz and assorted spurious responses may be generated in the mixer from other frequency combinations as well. Once the frequencies are set to an approximate 30 MHz difference using the frequency meter, with the klystrons set to the center of their modes, final adjustment may be made using the Receiver. The XTAL position of the OUTPUT meter may be used for a tuning indicator and to observe the frequency meter dip during preliminary adjustment. After this has been done, back off the signal klystron power and adjust the LO level for 1.5 ma mixer current as read on the 3 scale of the OUTPUT meter with the OUTPUT switch in the 3 position.

2-43. Final Frequency Adjustment. Make the final frequency adjustment as follows:

a. Set XTAL-OUTPUT switch to OUTPUT position; set REF-RCV-COMP switch to RCV; set AFC switch to OFF; set OUTPUT switch to 30; and adjust GAIN control to maximum cw position.

b. Apply a signal from klystron and adjust reflector voltage on LO klystron for an indication on OUTPUT meter.

NOTE

If frequencies have been carefully set with frequency meter (paragraph 2-42), only a minimum of LO klystron reflector adjustment should be necessary for OUTPUT meter indication.

c. After adjusting LO reflector voltage for an approximate maximum indication on OUTPUT meter, adjust LO reflector voltage for zero indication on FREQUENCY DEVIATION meter. After proper adjustment, a small reflector voltage change in one direction should cause a rapid change in meter reading in the opposite direction and vice-versa.

NOTE

When making measurements below about -90 dbm, noise is present in the AFC system. It is therefore necessary to set klystron frequency as close as possible to zero indication on the FREQUENCY DEVIATION meter (with AFC OFF) to minimize the effects of AFC noise. The frequency can be adjusted at a low level, around -70 dbm or so, and the adjustment will hold throughout the range.

d. Set AFC switch to INT (+ or - depending on whether the LO is above or below the signal). If LO is below, AFC will hold on INT (-) and vice-versa. It should be obvious that AFC has locked on by observing FREQUENCY DEVIATION meter action; it should indicate near zero after AFC has locked on.

NOTE

If FREQUENCY DEVIATION meter indication oscillates, reduce AFC loop gain by adjusting AFC GAIN potentiometer on rear panel in ccw direction until oscillation ceases.

e. Set REF-RCV-COMP switch to COMP position; AFC should still be locked on and indicate very near zero on FREQUENCY DEVIATION meter.

f. The Receiver is now in an operational status.

2-44. External Switching Considerations. If external switching is used, it will be necessary to adjust the signal source for proper modulation before the final frequency adjustment. It must be modulated cleanly and be in the proper phase with respect to the Receiver reference oscillator modulation. When a klystron is used, phase of the modulation will change 180° when reflector voltage is switched from one side of a mode to the other side of the same mode. In signal generators, a phase reversal switch is frequently included for the modulation. Signal modulation must be such that the signal and reference oscillator are on alternately. Modulation waveform may be observed by operating the Receiver in the RCV position and displaying the AC output on an oscilloscope. If the scope is synchronized with the 1 KHz output from the Receiver, phase of the signal modulation with respect to the reference is easily determined. Once the user has become accustomed to operation of the Receiver, it will be immediately apparent if the signal is not in proper phase; if such is the case, the front panel 1 KHz EXT MOD control may be reversed.

2-45. Final tuning on the detector mount mixer should be for the maximum 30 MHz output signal. Usually, there will be a slight difference in tuning between maximum LO mixer current and maximum i-f signal out. If measurements are being made to low levels, it is important that i-f output from the mixer be maximized.

2-46. TYPICAL MEASUREMENTS. Several typical measurements for attenuation, absolute power level, signal generator calibration, linear and log operation, external AFC and low-level Receiver operation are presented in paragraphs 2-47 through 2-54 which follow.

2-47. Attenuation Measurement. (See figure 2-2.) Set up the equipment as shown in figure 2-2, but without the "unknown" in place. The following procedure assumes that all necessary tuning adjustments, and VTVM and AFC zero adjustments, have been made. Perform the attenuation measurement as follows:

a. Check OUTPUT meter for 1.5 ma crystal current with XTAL-OUTPUT switch in XTAL position.

b. Check AFC tuning by setting AFC switch to OFF position. If necessary, adjust LO reflector for near zero indication on FREQUENCY DEVIATION meter. Set AFC switch to INT (+ or -).

c. Set ATTENUATOR control to 20.00 db on DB readout window. This places Receiver in its most accurate range if "unknown" is between zero and 60db.

d. Set REF-RCV-COMP switch to COMP and XTAL-OUTPUT switch to OUTPUT. Adjust signal level for zero on NULL meter. This establishes a reference level.

e. Insert "unknown" into microwave setup (figure 2-2).

NOTE

Care should be exercised to minimize physical shock to the setup and components when inserting the "unknown". It may be helpful to use a section of guide in place of the unknown while setting up the reference level to avoid rearrangement of components when the "unknown" is inserted.

f. After the "unknown" is in place, adjust ATTENUATOR control for zero indication on NULL meter. This control is always turned in a direction to bring the NULL meter back on scale; that is, if NULL meter is off scale to left, turn ATTENUATOR control to right and vice-versa. After new null is established, note attenuation in DB readout window.

g. Subtract initial reading (20.00 db) from new reading; difference is attenuation of "unknown".

NOTE

It may be desireable to repeat the measurement once or twice if extreme accuracy is necessary. Variations in mechanical connections, and slight power variations may be eliminated by taking several readings and averaging the results. If the "unknown" exceeds 60 db, it is advisable to repeat the measurement starting at a high level, say 10.00 db.

2-48. Absolute Power Level Measurement. Since the reference oscillator signal in the Receiver is applied to the i-f strip after the mixer, it is an indication of 30 MHz i-f output signal from the mixer. Actual r-f power level applied to the mixer may be measured by calibrating the mixer and Receiver together. If a Narda Microline 34( )1 detector mount is used as the mixer, the mixer crystal may be removed and a barratter inserted directly. A power meter may be connected to the mount and a level (1 mw is convenient) set up. The mount must be retuned with the barretter since it will present a different match to the system from the crystal. After the reference level is established, the crystal is replaced and the mount retuned. Maximum level for the Receiver is nominally -10 dbm in the guide, so the reference power must be reduced by a known amount to fall within the Receiver range. A calibrated variable attenuator or a fixed attenuator may be inserted in the setup and the ATTENUATOR control adjusted for null indication. With an initial level of 1 mw, if the Receiver indicates a null at 5.00 on its DB readout with 20 db of attenuation inserted in the setup, then 5.00 corresponds to -20 dbm. This calibration holds for the mixer and frequency used for the calibration. If the mixer or frequency is changed, the conversion gain of the system may also change and a new calibration is required. The attenuator inserted to reduce the level may be measured with the Receiver so the power reduction from the initial level is known very accurately. The entire power measurement will then depend on the accuracy of the equipment used to set up the initial power level. Perform the power level measurement as follows:

a. Replace mixer crystal in the 34X1 Detector Mount with a bolometer element.

b. Connect a power meter such as Narda Microline Model 440C to Detector Mount. Remove all r-f power and zero power meter.

c. Apply power from signal klystron only until an indication is obtained on power meter. Tune 34X1 for maximum indication and then adjust power level to 1 mw.

d. Remove power meter and bolometer and replace crystal mixer in Detector Mount. Set XTAL-OUTPUT switch on Receiver to XTAL position and tune 34X1 for maximum crystal current.

e. If a fixed attenuator is used, insert it at point of "unknown" as shown in figure 2-2.

f. Adjust LO output for 1.5 ma crystal current.

g. Set XTAL-OUTPUT switch to OUTPUT; set REF-RCV-COMP switch to RCV; and set OUTPUT switch to 30. Adjust GAIN control for convenient indication on OUTPUT meter and then readjust 34X1 for maximum indication.

h. Set REF-RCV-COMP switch to COMP position and adjust ATTENUATOR control for zero indication on NULL meter.

i. Subtract DB readout from db loss in fixed attenuator (step e); difference attenuation is 000.00 power level for Receiver in -dbm.

j. If a variable attenuator is used in step e, it should be set to maximum attenuation when inserted. In step h, set ATTENUATOR control to 000.00 and adjust variable attenuator for zero on NULL meter. DB readout is 000.00 power level for Receiver in -dbm.

k. If 000.00 setting corresponds to -12 dbm for a given setup, then a null at 16.40 db on DB readout indicator indicates a signal level at mixer of 16.40 db below -20 dbm, or -28.40 dbm.

2-49. Signal Generator Calibration. Output attenuator calibration for signal generators is easily accomplished with the Receiver. If the Receiver power level calibration is performed as outlined in paragraph 2-48, output power level can be checked simultaneously. If a 30 MHz generator is being checked, no mixer is required. The setup of figure 2-2 may be used with an appropriate connection between the generator and the guide. Components required in the setup for matching the "unknown" may be omitted. After the generator and setup are adjusted for the desired operating frequency, set the Receiver for proper AFC operation and comparison operation. Perform the signal generator calibration as follows:

a. Set generator output at highest level to be used. If this exceeds 000.00 level of Receiver, insert attenuation between generator and mixer for zero indication on NULL meter. If generator level is less than Receiver 000.00 level, adjust ATTENUATOR control for zero on NULL meter.

b. Advance signal generator attenuator to first calibration point.

c. Adjust Receiver ATTENUATOR control for zero on NULL meter.

d. Subtract previous DB readout in step a from reading obtained in step c. Difference reading is inserted attenuation.

e. Repeat steps b, c and d for subsequent calibration points as desired.

f. If power limit of Receiver range is reached and additional points are desired at lower levels, attenuation inserted in step a may be removed and Receiver ATTENUATOR control readjusted for null. Additional measurements may now be made from this new reference point.

NOTE

If no attenuation was inserted in step a, the lower limit of calibration with the Receiver has been reached.

2-50. Log Operation. The Receiver may be used as a straight log response Receiver if desired. To accomplish this, set XTAL-OUTPUT switch to OUTPUT; set REF-RCV-COMP switch to RCV; and set OUTPUT switch to LOG; Receiver gain is set automatically with the OUTPUT switch in this position, and the OUTPUT meter log scale is used for readout. Log response is accurate to 3% or better. The meter scale is calibrated from full scale downward to facilitate use for antenna patterns or similar response measurements. A RECORDER jack is provided on the Receiver rear panel for graphic recorder use in these measurements.

2-51. Linear Operation. For linear Receiver operation, set the XTAL-OUTPUT switch to OUTPUT; set the REF-RCV-COMP switch to RCV; and set the OUTPUT switch to the VTVM scale desired (1, 3, 10 or 30). The OUTPUT meter (now a VTVM) indicates the DC voltage at the i-f video detector; i-f strip gain is adjusted with the GAIN control. With this control in the maximum ccw position, approximately 0.1-volt at 30 MHz is required at the IN jack to produce 30 vdc at the video detector. AC voltage at the AC VIDEO output jack is indicated on the OUTPUT meter with the OUTPUT switch in the AC position. Full-scale sensitivity is -10 volts rms.

2-52. External AFC Control. External AFC control may be used with the Receiver by applying the external control voltage to the EXT AFC jack on the rear apnel. Approximately 1 volt is required for 25 volts change at the klystron circuit. Polarity of external AFC can be selected from the front panel.

2-53. Low Level Receiver Operation. If the Receiver is used as a straight receiver at low levels, the ATTENUATOR control must be turned for maximum DC readout. The reference oscillator diode output switch inserts approximately 60-db isolation. The reference signal will be approximately 60-db below the attenuator DC readout and may interfere with low level Receiver operation if high attenuation is not used.

2-54. ACCURACY TABLES. Table 2-2 relates Receiver measurement accuracy to input signal level. Inspection of this table will assist the operator in selecting a measurement range which will give the most accurate results.

Table 2-2. Measurement Accuracy vs. Input Signal Level

Total Single Step (db)	Starting Level (dbm)	Max. ±db Error for Single Step
1-10	-25	0.06
10-20	-25	0.07
20-30	-25	0.08
30-40	-25	0.10
40-50	-25	0.11
50-60	-25	0.13
60-70	-20	0.16
70-80	-20	0.19
80-90	-15	0.28
90-100	-10	0.49

2-55. RESHIPMENT

2-56. If possible, in the event the Receiver was damaged during shipment, or if the equipment requires repair, use the original packing container and materials. If a substitute shipping container is used for reshipment, make certain that it has strong cardboard or wooden sides and heavy wrappings. The Receiver should be surrounded by ample padding when placed in the container. After packing, the container should be clearly marked "FRAGILE" and "DELICATE INSTRUMENT" on the surfaces.

Section III
Theory of Operation

3-1. GENERAL

3-2. This section presents an analysis of the circuits incorporated in the Receiver and is divided into two basic parts. The first portion concerns itself with a comparison between the series and parallel substitution methods of attenuation measurements; the second portion provides a functional description of the equipment based on a functional block diagram and simplified schematic diagrams.

3-3. METHODS OF ATTENUATION MEASUREMENT

3-4. Attenuation measurements are made most accurately by substituting the insertion loss of a calibrated element for that of an unknown element in the test setup. Substitution systems are classified according to the point in the setup at which the substitution is made. They include r-f substitution, audio substitution and i-f substitution. The latter, which may be either series or parallel, is generally considered the most accurate.

3-5. SERIES SUBSTITUTION. (See figure 3-1.) In series i-f substitution systems, the standard, or reference attenuator is inserted in series with the signal. Figure 3-1 is a block diagram of a typical series substitution arrangement. A preamplifier is required in the signal path prior to the attenuator to prevent serious degradation of receiver noise figure due to attenuator insertion loss. With this arrangement, it is extremely difficult to realize the full accuracy capabilities of the attenuator over a wide dynamic range because of non-linearity in the preamplifier. In addition the level indicator, in series substitution equipment, must operate on dc, making if difficult to display small excursions with good stability. Perhaps the most serious disadvantage of this method is the sensitivity to gain changes in the system. Both the preamplifier and the i-f strip must possess a very high degree of gain stability for accurate results. Mixer linearity is not usually a problem, except at high signal levels.

3-6. PARALLEL SUBSTITUTION. In parallel substitution systems, a reference signal controlled by the standard attenuator is inserted in parallel with the signal. Figure 3-2 is a block diagram of a typical parallel substitution arrangement. Signal switching or modulation is accomplished in the receiver input circuit; the setup shown will be referred to as an "internal switching" setup. In this method, the i-f strip input is alternately connected to the signal and to the reference oscillator output from the attenuator by a switching operation in the equipment. The two signals are compared in a synchronous detector; the output is displayed by a null indicator. It is therefore possible to adjust the reference level to correspond to changes in signal level to a high degree of accuracy. Not only can the null indication be made very sensitive, but any null indicator error is constant and cancels out. All major disadvantages of the series substitution systems are eliminated, since there is no preamplifier; gain changes in the i-f strip affect the signal and the reference equally; and a synchronous detector is used which permits stable indication of small changes in signal level. It is possible to realize the full accuracy of the attenuator over wide dynamic ranges, except for the extreme ends of the operating range, since errors other than the attenuator are virtually eliminated.

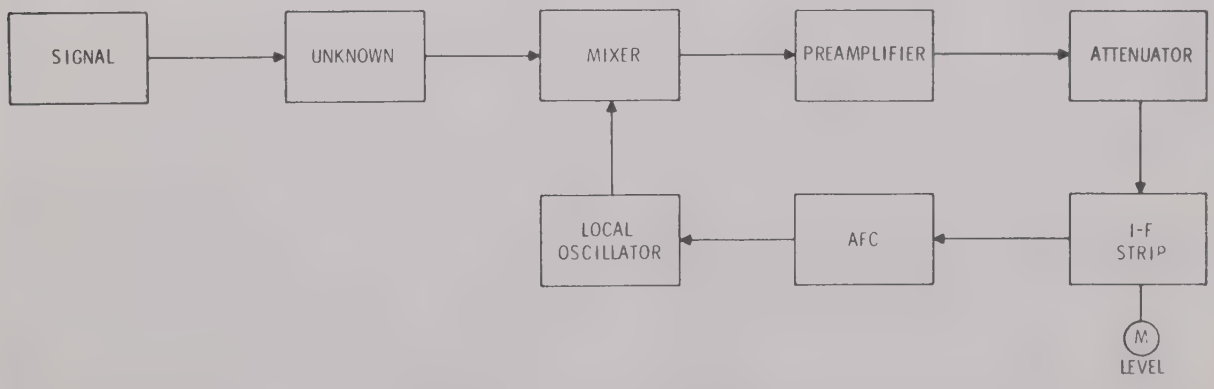


Figure 3-1. Series Substitution

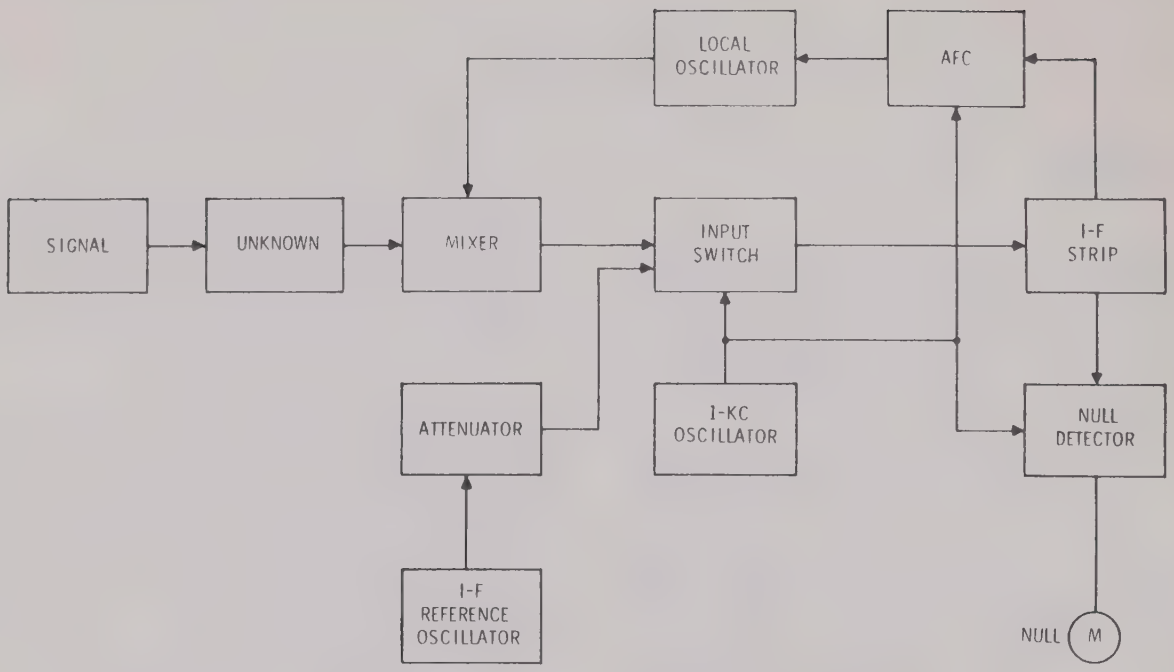


Figure 3-2. Parallel Substitution (Internal Switching)

3-7. At the high level end of the signal range, mixer non-linearity will be significant when the signal is no longer small compared to the local oscillator level. There is approximately 0.05-db error when the local oscillator signal is 30-times greater than the signal; the error increases considerably as the ratio decreases.

3-8. The lower end of the measurement range is determined by system noise figure. Noise output from the mixer is switched as well as the 30 MHz signal from the mixer. When mixer noise is no longer small compared to the signal, it will result in a measurement error, since the internal reference is being compared to the net input signal. In the Receiver, a dynamic reange of approximately 75 db (-10 dbm upper limit) can be covered satisfactorily using internal switching. The lower limit of approximately -85 dbm can be realized with a single-ended mixer and approximately 10 db mixer noise figure. Mixer noise coherence may be eliminated by switching the signal externally, resulting in an extension of the lower limit.

3-9. Since the signal and the reference are alternately applied to the i-f strip, the two frequencies may by compared and an AFC correction voltage generated. A synchronous detector is used in the AFC unit and the incoming signal is locked to the reference oscillator frequency.

3-10. Null or balance indication is very nearly constant over the entire measurement range. Sensitivity is decreased at the lower end of the range because of system noise.

3-11. Waveguide mechanical instabilities, power supply changes, and other variations in the setup may cause null meter deflections which make it difficult to determine a null accurately. Under such conditions, the null sensitivity can be reduced to maintain a useable indication. On the Receiver, a front panel X1-X10 switch is included to permit a 10:1 reduction in sensitivity, if desired.

3-12. EXTENSION OF DYNAMIC RANGE. Dynamic range may be extended at the lower end by removing mixer noise coherence. Elimination of mixer noise coherence requires signal modulation prior to mixing, rather than after it. Signal switching or modulation is therefore performed at the external source; the setup shown in figure 3-3 will be referred to as an external switch setup. In the r-f setup, the signal source is modulated 180 degrees out of phase with the Receiver internal reference by using the 1 KHz OUT signal. The modulated signal and the modulated reference are then applied to the i-f strip input in the presence of a constant mixer noise level. With mixer noise modulation removed, measurements are possible at input signal-to-noise ratios considerably less than 1. The lower measurement limit is still determined by the mixer noise in a given setup; however, with commonly encountered noise figures, accurate measurements are easily made down to -110 dbm. AFC operation is identical to that used in internal switching.

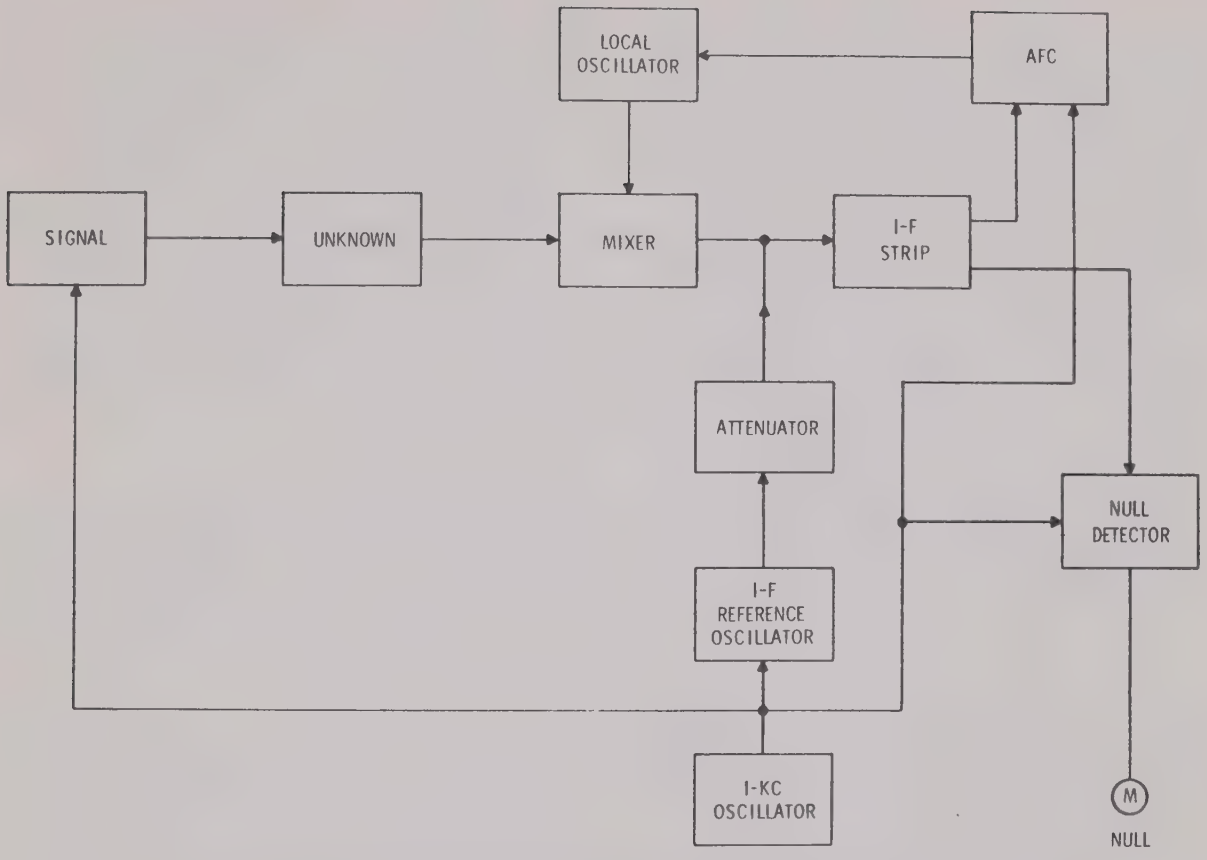


Figure 3-3. Parallel Substitution (External Switching)

3-13. SOURCES OF ERROR. The parallel substitution system inherently has less error than the series substitution system because nearly all the quipment is common to both the signal and reference. If there were no external error sources, measurement errors would be reduced essentially to those of the attenuator. Accuracies of 0.05 db/10 db or better are not uncommon for cut-off type attenuators in i-f substitution systems; therefore, excellent accuracy is obtainable in practice.

3-14. The mixer is the principal source of external error; however, it contributes significant error only at the extremes of the operating range. At high levels, errors due to mixer non-linearity are present if the local oscillator-to-signal ratio is too small. For a given local oscillator power level, linearity error will appear, and increase rapidly as the signal increases above about 1/20 of the local oscillator level. The absolute input level at which errors become significant can be raised almost indefinitely by increasing the local oscillator level, with the upper limit being crystal burnout.

3-15. At low signal levels, mixer noise will introduce errors at very low signal-to-noise ratios. These errors can be reduced for a given receiver only by improving the mixer noise figure. Some improvement can be made by reducing the local oscillator power; however, the local oscillator power can be reduced only until the conversion loss begins to increase. Once the conversion loss does begin to increase, it increases very rapidly and overall performance deteriorates.

3-16. With respect to the mixer, the measurement range is limited at the lower end by noise (which increases with increased local oscillator power) and at the upper end by non-linearity (which can be improved only with increased local oscillator power). Total dynamic range increases somewhat as the local oscillator power increases since the lower end limit does not rise at the same rate as the upper end is improved. Minimum useful power level at the lower end will be higher, however, and the operating local oscillator level for measurements will usually be a compromise between the actual power levels involved and the dynamic range to be covered.

3-17. There are other factors which may contribute errors to the measurement, but they are difficult to evaluate for the general case.

3-18. FUNCTIONAL DESCRIPTION

3-19. The following discussion in paragraphs 3-20 through 3-49 is referenced to the functional block diagram, figure 3-4; the remaining circuit descriptions are referenced to applicable simplified schematic diagrams. Reference should also be made to the equipment schematic diagrams located in Section IV.

3-20. INPUT SWITCH. The input switch has two functions; it modulates the 30 MHz signal from the mixer when internal switching is used, and it inserts the 30 MHz reference oscillator signal from the attenuator in both internal and external switching modes. High conductance germanium diode switching elements are controlled by the application of the proper voltage polarity to the switching control line. When the switching voltage is negative, the input signal diode is biased off, disconnecting the mixer and connecting the cable; a compensating network is also inserted to replace the mixer resistance and capacitance which have been disconnected. Application of a positive voltage to the control line biases the compensation circuit diode off and turns on the signal diode. When internal switching is used the positive and negative voltages are alternate half-cycles of the 1 KHz squarewave. In the external switching mode, the external signal source is modulated and a fixed positive voltage is applied to the switching line, disabling the internal signal switching operation. The mixer crystal current dc return is connected to the XTAL-OUTPUT switch to provide a crystal current indication on the OUTPUT meter.

3-21. The attenuator is a waveguide-below-cutoff design. Its attenuation characteristics are related precisely to its physical dimensions; therefore, once the mechanical design is established, it is possible to reproduce an attenuator of known characteristics with excellent accuracy. The Receiver attenuator uses a precision lead-screw drive with an in-line counter DB readout. Attenuation error is 0.05 db/10 db or less. Two principal sources of error are variations in transmission tube diameter and errors in the lead screw. Tube diameter is closely controlled in the attenuator and contributes little to any observed error. Lead-screw errors tend to be cyclic rather than cumulative and permit overall measurement accuracy with the Receiver of 0.5 db or better over a 100 db range. The attenuator input and output coupling circuits have a 50-ohm impedance and are broadly tuned at 30 MHz.

3-22. REFERENCE OSCILLATOR. A two-stage vacuum tube oscillator supplies the 30 MHz reference signal. A third overtone crystal-controlled triode oscillator stage drives a pentode output amplifier to provide the necessary output level. Cathode bias in the pentode amplifier is adjusted to set the reference oscillator signal output voltage. An approximate 2.35-volt reference signal is available at the 30 MHz OUTPUT jack on the rear panel. Reference signal switching is accomplished in the reference oscillator by a high-conductance germanium diode in a manner similar to that of the input switch. Switching of the reference signal is accomplished prior to the attenuator to permit switching at a constant level, thereby removing any possibility of error due to switch variations with different levels. It also simplifies insertion of the reference signal when external signal switching is used. Filament and plate voltages for the reference oscillator are regulated for stable operation.

3-23. I-F STRIP. The i-f strip contains six tubes, four in the 30 MHz amplifier and two in the AFC discriminator. High-performance frame grid tubes are used to obtain very stable i-f characteristics. These tubes are very uniform in characteristics from one tube to the next, minimizing the readjustment required when replacing i-f strip tubes.

3-24. A cascade input amplifier is used to obtain low noise figure. Two remote-cutoff pentode amplifiers permit smooth gain control with external voltages. A sharp-cutoff pentode amplifier drives the video detector which is a voltage doubler using two germanium diodes. The output signal from this amplifier is also connected to a pentode limiter driving the dual-diode discriminator.

3-25. The amplifier is synchronously tuned throughout, and has a bandwidth of approximately 1 MHz at the 3 db points. I-F strip noise figure is 1.5 db or better; however, losses in the input switch result in an overall Receiver noise figure of approximately 3 db. AFC discriminator sensitivity is approximately 4 volts/MHz.

3-26. Both cathode and grid returns for the remote cutoff stages are brought out for gain control purposes.

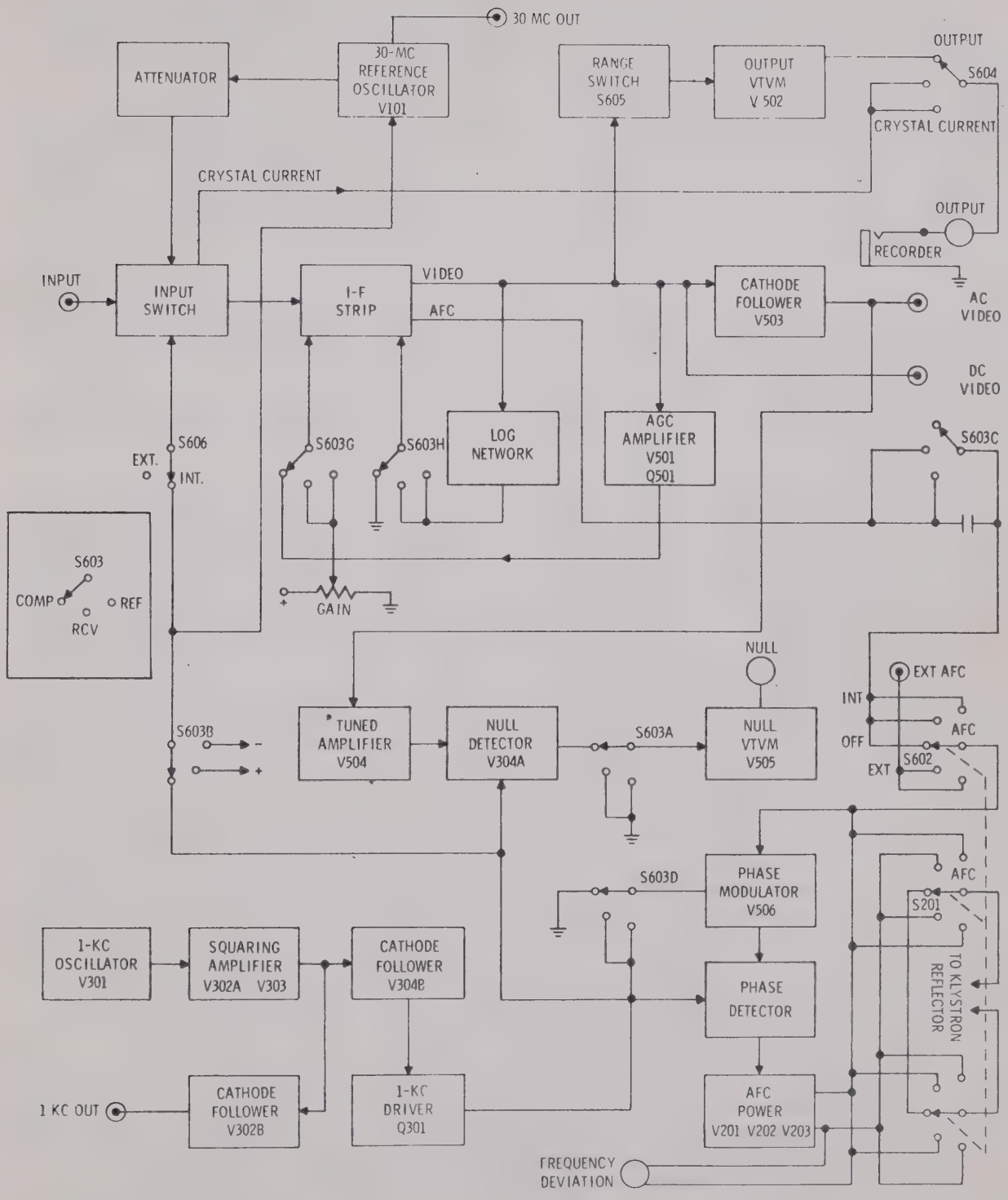


Figure 3-4. Receiver, Functional Block Diagram

3-27. AGC AMPLIFIER. (See figure 3-5.) Automatic gain control of the i-f amplifier is required to maintain constant null sensitivity over the Receiver operating range. For a given full-scale sensitivity in db, there will be a corresponding voltage ratio at the i-f detector. However, a vtvm is used for null indication, and operation is based on an absolute input voltage. It is therefore necessary to normalize the i-f strip output to permit a uniform db indication on the vtvm. In comparison operation, the OUTPUT meter indicates AGC voltage applied to the i-f strip gain control line. The i-f detector output is very nearly constant over the operating range with AGC operation.

3-28. The AGC amplifier consists of a two-stage vacuum tube dc amplifier and a transistor. The dc amplifier is conventional and uses an NE2A neon bulb for db coupling between stages. The transistor is inserted in the cathode return line of the i-f amplifier remote-cutoff stages; transistor current is controlled by the vacuum tube dc amplifier. When the transistor is conducting fully, the voltage drop across it is only a few tenths of a volt and has little biasing effect on the i-f amplifier. However, as the transistor drive is reduced, its current capacity is reduced, and the i-f stages are back-biased, thereby reducing the gain. The AGC amplifier is used only on comparison operation. The cathode return line is grounded for log operation and connected to a manual gain control for other types of operation.

3-29. LOG NETWORK. In any amplifier using remote cutoff tubes, if the detected output is returned to the amplifier grids as bias, a response is obtained which approximates a logarithmic function. In the Receiver, a network is inserted in this feedback loop to shape the bias for true logarithmic response. Correction is adjusted for a logarithmic indication 60-db down from full scale on the OUTPUT meter. This method lends itself to convenient indication of passband response, antenna patterns, and similar applications; response is corrected to within 3% over the 60-db range.

3-30. OUTPUT VTVM. The output vtvm is a conventional balanced cathode-follower circuit and is used to indicate video output, ac video output and output voltage in log response. A separate isolated power supply is used for this circuit to permit grounding one side of the OUTPUT meter circuit, facilitating use of a recorder or other output monitoring device.

3-31. CATHODE FOLLOWER (V503). A conventional cathode follower is used to isolate the i-f amplifier output from the DC VIDEO output jack and other circuits, using the ac signal from the i-f video detector.

3-32. TUNED AMPLIFIER. The tuned amplifier includes the 1 KHz parallel-tuned circuit and a two-stage amplifier. All circuits are conventional.

3-33. NULL DETECTOR. (See figure 3-6.) The null detector consists of a half-wave semiconductor detector and a split-load phase inverter which applies a push-pull null signal to the detector. Reference signal drive for the detector is obtained from the 1 KHz squarewave driver. Operation of the null detector is conventional. The filtered output signal from the detector balance potentiometer is applied to the null vtvm.

3-34. NULL VTVM. A straightforward balanced plate vtvm circuit is used with a zero center NULL meter. Precision resistors are used in the amplifier plate circuit for stable operation over extended periods.

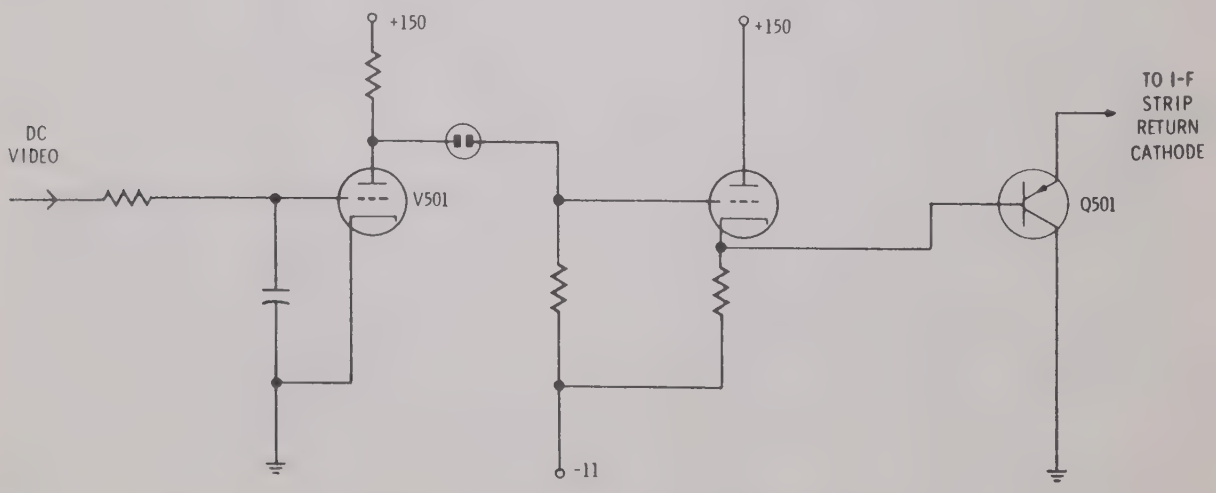


Figure 3-5. AGC Amplifier, Simplified Schematic

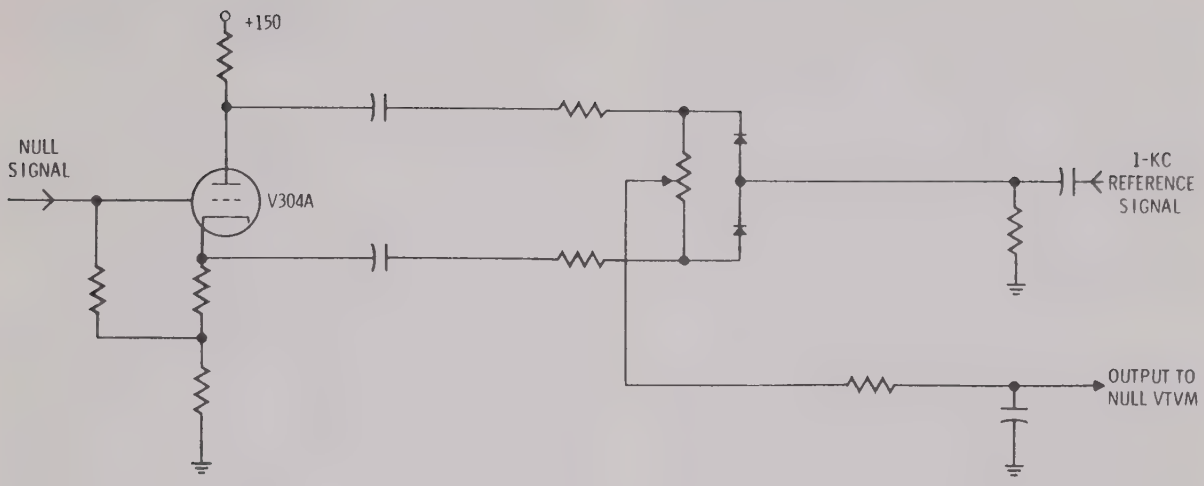


Figure 3-6. Null Detector, Simplified Schematic

3-35. 1 KHz OSCILLATOR. A bridged-T r-c tuned oscillator is used for the primary 1 KHz source. Precision resistors and stable capacitors are used in the frequency determining circuit to provide long-term frequency stability. The circuit is also stabilized, by a thermal element, against amplitude changes. The resulting circuit is not sensitive to tube characteristics.

3-36. SQUARING AMPLIFIER. The oscillator output signal is amplified in a single triode amplifier and clipped in a two-stage regenerative slicer. Slicer bias and amplitude are selected for minimum phase offset between the output squarewave and input sine-wave.

3-37. CATHODE FOLLOWER (V304B) AND 1 KHz DRIVER. (See figure 3-7.) The 1 KHz squarewave output of the slicer is applied to the 1 KHz driver, an NPN transistor, through an isolating cathode follower. The cathode follower provides power gain for the transistor base circuit and drives it from full on to cutoff. When the transistor is turned on, collector current flows from the -11 volt supply through the transistor and a winding of transformer T202 to ground. When the transistor is turned off, the field in the transformer winding collapses and generates the other half-cycle of the squarewave of opposite polarity. To limit the voltage excursion associated with the collapse, a zener diode and rectifier are used. When the transistor is on, the rectifier is biased in the reverse direction and does not conduct. When the transistor is off and the inductively generated voltage is present, the rectifier conducts and the zener diode operates.

3-38. CATHODE FOLLOWER (V302B). A cathode follower isolation stage is used to couple the 1 KHz squarewave to the 1 KC OUT jack. This also provides a low impedance output which is necessary to prevent deterioration of the squarewave by cables which will be attached to the 1 KC OUT jack during operation.

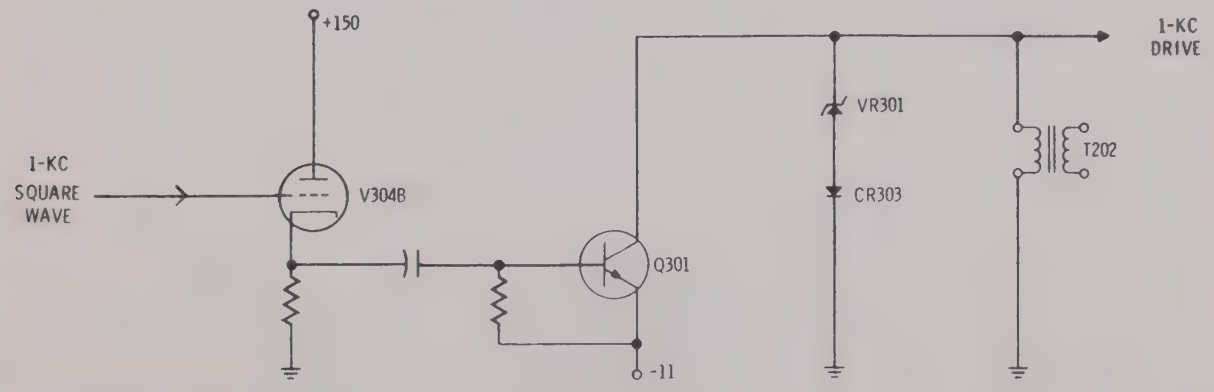


Figure 3-7. Cathode Follower and 1 KHz Driver, Simplified Schematic

3-39. PHASE MODULATOR. (See figure 3-8.) The Receiver AFC deck is used on both comparison and single signal operation. In comparison operation, the input signal and the reference signal are alternately applied to the discriminator. If there is a frequency difference between them, the discriminator output is a squarewave whose amplitude indicates the amount of difference and whose phase (with respect to the modulation) indicates whether the signal is above or below the reference. AFC operation attempts to minimize the 1 KHz output of the discriminator and therefore locks the incoming signal to the reference frequency. This system is virtually independent of discriminator tuning.

3-40. In straight Receiver operation, there is no switching. The discriminator output is a dc voltage whose magnitude indicates the frequency difference between the signal and the center frequency tuning of the discriminator, and whose polarity indicates the direction from the center frequency (above or below).

3-41. The phase modulator operates essentially as an amplifier with the comparison signal. In figure 3-8A, tube V506 is connected for comparison operation. Tube V506 is a sheet beam tube (6AR8) containing two plates and a pair of deflection electrodes. When the deflection electrode potentials to ground are balanced, the cathode current divides evenly between the two plates. As the potentials are unbalanced, the plate current balance will also shift, and a difference of potential will exist between the plates. Since a transformer is used in this circuit, only changes in plate current will be evident and the initial plate current balance is not important to proper operation. The signal grid of V506 is grounded for this mode of operation, and the tube function is essentially that of a phase inverter. The 1 KHz output from the discriminator is applied to the deflection plate and appears as a push-pull signal on the primary of transformer T202.

3-42. In straight Receiver operation, it is necessary to generate the same push-pull signal from a dc discriminator output. A 1 KHz squarewave is now applied to the signal grid as in figure 3-8B. If the two plate currents are balanced, they will generate squarewave signals of equal amplitude on both plates. However, the net ac voltage between the plates is zero since they both receive the modulated beam from the same source. If the amount of current is unbalanced, the plate signals are no longer equal and a net signal will appear on the transformer primary. The phase of the difference signal with respect to the grid signal will depend upon which way the beam was deflected. Therefore, if the tube is initially balanced, a positive signal on a deflection plate will generate one phase at the output and a negative signal will generate the opposite phase. In the Receiver, tube V506 is balanced with no discriminator output by the AFC ZERO control, which adjusts the deflection plate voltage on one half of the tube. DC output from the discriminator is then applied to the other deflection plate and the ac error signal is generated as in the case of comparison operation.

3-43. Under some conditions of operation, the AFC loop gain may exceed its stable value, resulting in oscillation. This condition, which causes periodic oscillation of the FREQUENCY DEVIATION meter indication, is caused mainly by klystrons which have very high tuning rates with reflector voltage variation. The AFC GAIN control permits a reduction in the loop gain if this condition occurs.

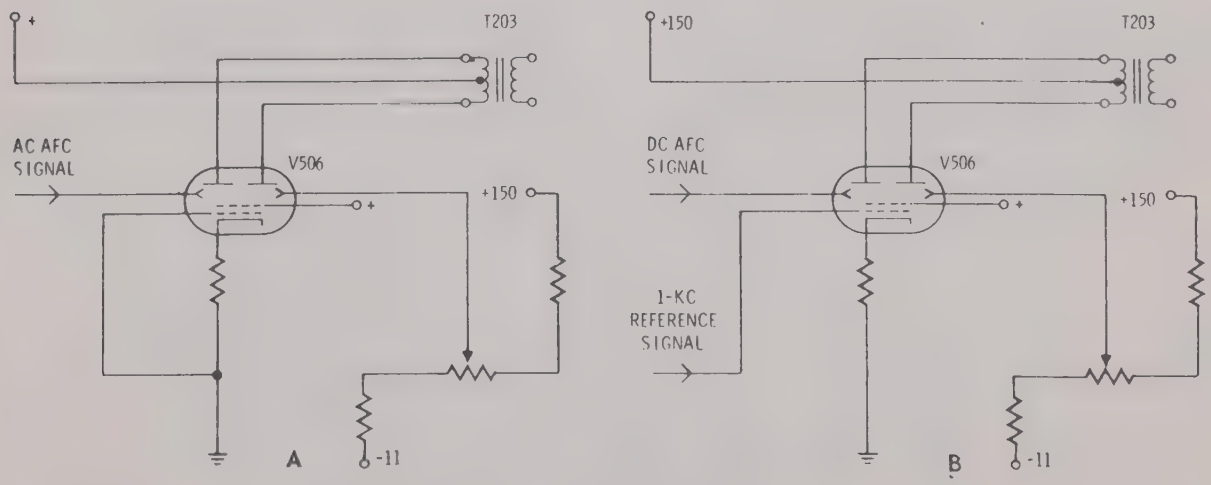


Figure 3-8. Phase Modulator, Simplified Schematic

3-44. PHASE DETECTOR. The phase detector uses two silicon rectifiers and operates as a full-wave synchronous detector. Transformer T202 supplies the 1 KHz reference signal and transformer T203 couples the AFC signal from tube V506. Both transformers are insulated for 5000 volts working voltage to permit use with klystrons or other devices having voltage requirements up to that value.

3-45. AFC POWER SUPPLIES. A power supply with two regulators supplies voltage for AFC correction. One regulator operates from a VR tube; the second regulator operates from the first. Since the two regulator output voltages are connected in opposition, it is only necessary that they be regulated with respect to each other. Outputs are set for a zero net voltage with no output from the phase detector. Voltage from the phase detector, corresponding to a signal from the AFC discriminator in the i-f strip, unbalances one of the supplies, providing a net difference between the two regulator outputs. The difference voltage will be positive or negative depending on the polarity of the phase at the detector output. This arrangement permits AFC correction on devices which draw current in the corrected circuit. The high impedance of reflector circuits used with klystrons require the use of the filter consisting of R215 and C207. Resistor R215 limits the AFC circuit current to a low value. Up to 20 ma current in the AFC circuit may be obtained by shorting resistor R215.

3-46. MAIN POWER SUPPLY. The main power supply furnishes the following voltages:

a. Floating 150-volt supply for the output vtvm.
b. 6.3 volts ac unregulated for filaments.
c. Negative 11 volts zener-regulated dc.
d. Negative 22 volts unregulated dc.
e. Positive 150 volts regulated.
f. 6.3 volts rms regulated for filaments.

3-47. Circuits are conventional except for the +150-volt supply and the regulated filament supply.

3-48. In the Receiver, the B+ regulation is more important than a specific voltage. (See figure 3-9.) Drive for the gate transistor is obtained from a negative supply (which tends to turn it on) and from the positive supply through a VR tube (which tends to turn it off). The VR tube is a constant-voltage variable-current device which is well-suited to controlling base drive on a transistor. The very low voltage drop of the transistor at relatively low current permits low supply voltage and low gate power dissipation. Regulator operation is straightforward. As the B+ tends to increase, base current decreases in the transistor, increasing its voltage drop and reducing the output voltage. If the supply should be short-circuited, the VR tube will extinguish and the transistor will attempt to pass saturation current which is limited by the size of resistor R1 and the negative supply voltage. The Receiver +150-volt supply is therefore not damaged by a short circuit. A prolonged short circuit on the +150-volt supply will cause the line fuse to fail, but will not damage the components in the power supply. When power is first applied to the Receiver, the +150 volt load (which is primarily vacuum tubes) is very light. Under these conditions, it is possible to exceed the maximum voltage rating on the gate transistor. The thermistor and NE2A neon bulb protect the transistor from overvoltage under temporary or transient conditions. With no current, the thermister resistance is three to four times its operating resistance. When the transistor voltage drop reaches the ignition potential of the NE2A, it will ionize, limiting the voltage to approximately 65 volts and dropping the remainder across the thermistor. After the tubes warm up and the load is applied to the supply, the supply voltage drops, extinguishing the NE2A. The increased current heats the thermistor and reduces its resistance to the operating value. The NE2A does not operate except under high voltage conditions, such as initial turn-on. Output voltage from this regulator will vary with individual VR tubes, but this is of no consequence in the Receiver.

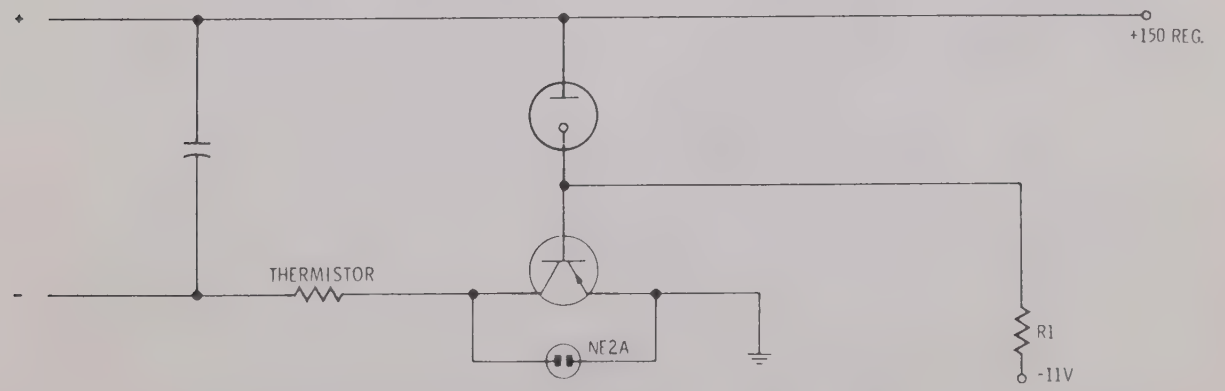


Figure 3-9. Positive 150-volt Regulator, Simplified Schematic

3-49. Operation of the filament regulator (figure 3-10) is similar to that of a zener diode. Load voltage is essentially a clipped sinewave. The full-wave rectifier is used to simplify the circuit since the regulator output provides only one polarity waveform to be clipped. If a full-wave rectified waveform is clipped off at a constant level, amplitude variations ahead of the clipper will be removed. The rms value of the waveform will still vary because the area under the remaining waveform changes slightly as the slope increases and decreases with initial peak amplitude. The lower the clipping level, relative to the peak amplitude, the less the rms variation. The process of reducing clipping level has practical limitations, however, since the clipped portion of the waveform represents lost power in the clipping device. In the Receiver regulator, as the waveform increases in a negative direction from zero, transistor Q1 will conduct because of base drive through resistor R1. Transistor Q2 will not conduct until the voltage at its base reaches the forward breakdown voltage of the two silicon rectifiers CR1/CR2 in its emitter return. These are low-cost silicon rectifiers whose forward drop is used for the reference. There will be no current through the rectifiers until the regulator output voltage reaches the forward breakdown voltage of the two rectifiers in series. As the input voltage continues to increase, the output voltage will follow it until transistor Q2 conducts. As soon as transistor Q2 conducts, the entire circuit will function as a conventional regulator, with CR1/CR2 as the reference. Regulator action will stabilize the output voltage even though the input continues to increase and it will remain at the regulated level until the input voltage drops to the point where the circuit drops out of regulation. The output voltage will then follow the input down to zero. This action will result in the clipped waveform shown. A compensating resistor may be added (shown dotted) to improve rms regulation. As the input waveform approaches its peak, and the rms value of the output tends to increase slightly, the compensating resistor will apply additional drive to transistor Q2 which will result in a depression or valley in the top of the clipped waveform. Any increase in input peak amplitude will tend to increase the amount of depression in the waveform and net change in the rms value can be held to a very small value. Output voltage is adjusted by setting the ratio of resistor R3 to resistor R4 in the feedback divider.

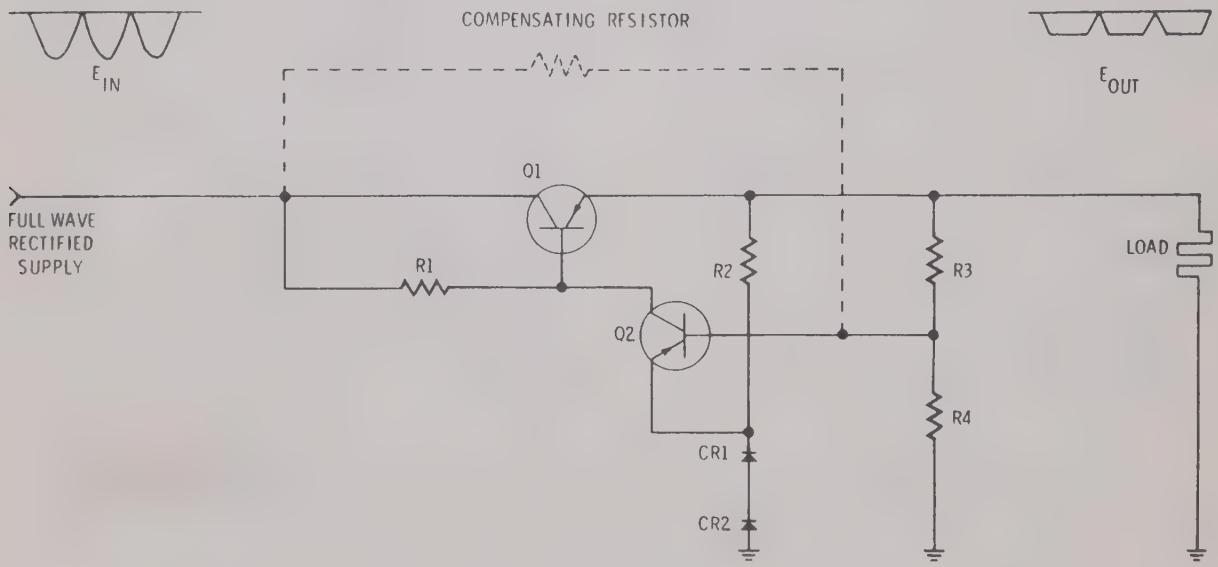


Figure 3-10. Filament Regulator, Simplified Schematic

Section IV
Maintenance

4-1. GENERAL

4-2. This section provides servicing information and instructions for performing alignment and adjustment of the Receiver.

4-3. PREPARATION FOR MAINTENANCE

4-4. No special procedures are required for setting up the Receiver preparatory to maintenance; set the unit on the test bench in close proximity to test equipment required for testing and a suitable ac line voltage source of 115 or 230 volts, 50 to 60 Hz.

4-5 TEST EQUIPMENT REQUIRED

4-6. The Receiver has been designed for adjustment with a minimum of external test equipment. In general, a vtvm and oscilloscope will be adequate for complete adjustment of the unit.

4-6. ALIGNMENTS AND ADJUSTMENTS

4-7. Alignments and adjustments for the Receiver are outlined in paragraphs 4-8 through 4-24. When making any adjustment, be certain that all preceeding adjustments have been executed in the order presented. See figures 4-1 and 4-2 for location of all internal adjustments.

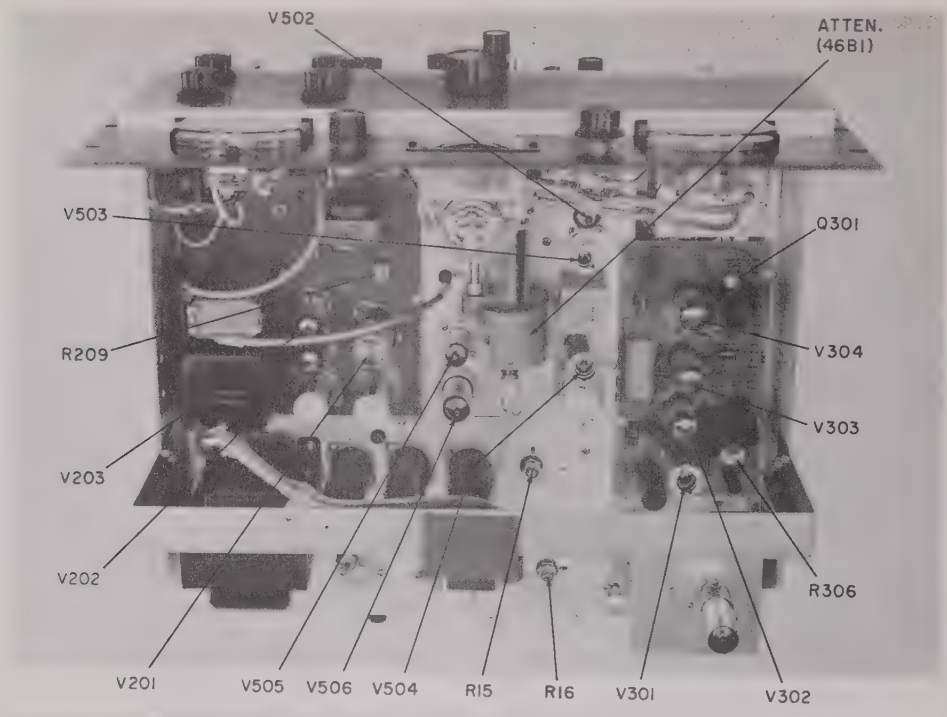
4-8. POSITIVE 150-VOLT SUPPLY. (See figure 4-3.) The +150-volt supply consists of a bridge rectifier, capacitor input filter, an OA2 150-volt reference stage and a gate transistor. Output voltage is determined directly by actual VR tube operating voltage, which may vary approximately $\pm$10% about 150 volts with different tubes. Supply regulation is approximately $\pm$0.5% with a 10% line voltage change. No voltage adjustment is provided for this supply since regulation is of primary importance and actual output voltage is not critical.

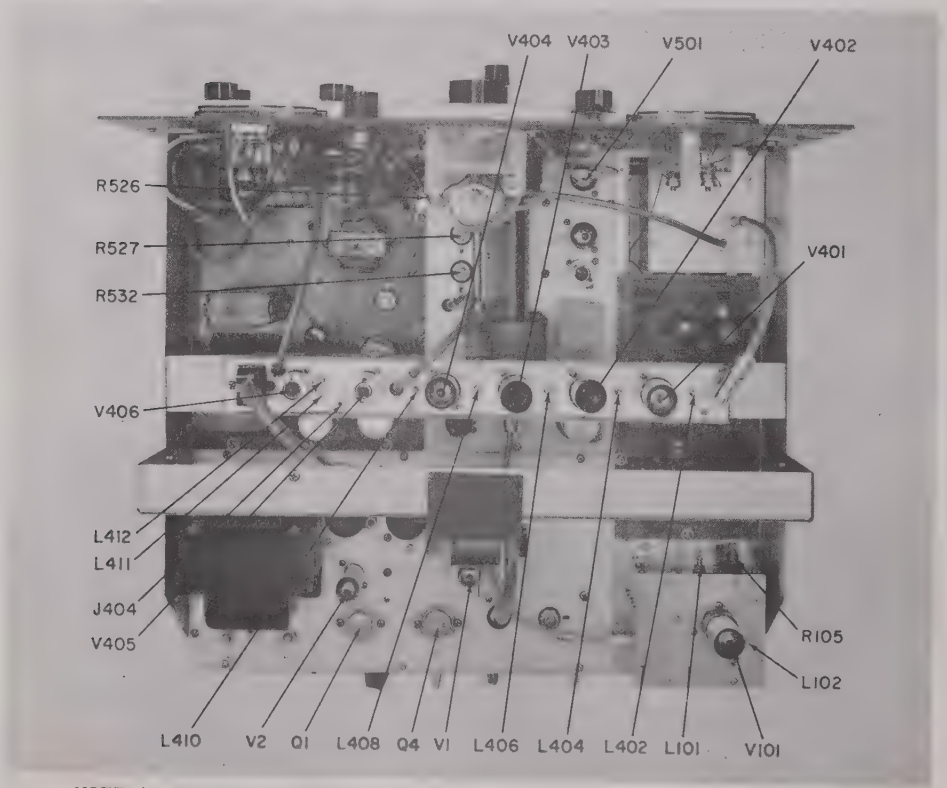
4-9. NEGATIVE 11-VOLT SUPPLY. (See figure 4-3.) The -11-volt supply output is regulated by a $\pm$20% tolerance zener regulator, CR17. No adjustment is provided in this supply.

4-10. REGULATED FILAMENT SUPPLY. (See figures 4-2 and 4-3.) The Receiver filament regulator operates as an automatic clipper and produces a clipped full-wave rectified sinewave. The filaments respond to the rms value of this waveform and adjustment is made for the equivalent average voltage corresponding to 6.3 volts rms. Perform the adjustment as follows:

a. With the Receiver operating in any mode, measure the voltage from the emitter of transistor Q1 to ground with an average reading voltmeter. An ordinary multimeter or vtvm is satisfactory.

b. Adjust potentiometer R5 on the terminal board for 5.9 volts dc as indicated by the average reading meter. This corresponds to 6.3 volts rms.





NOTE: 1. On later production units the positions of Q1 and Q4 are interchanged and these transistors are mounted on heat sinks, Narda part nos. 680-125A and 89506, respectively.
2. On later productions units, fan B601 position is rotated 180° from position shown and pointed downward at 30° angle toward Q1 and Q4.
3. On later production units Attenuator 46B1 is replaced by 46B2 equipped with TNC connectors.

Figure 4-1. Location of Internal Adjustments (Top View)

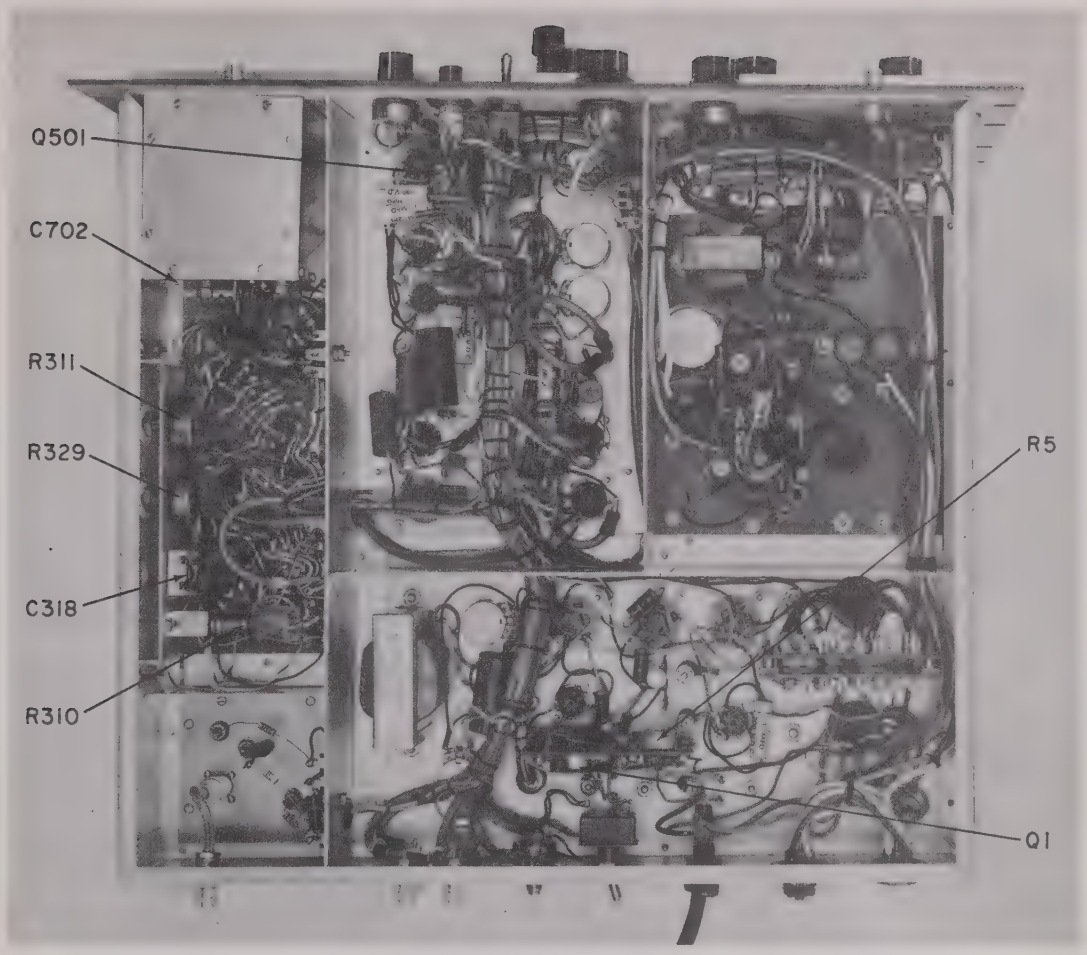


Figure 4-2. Location of Internal Adjustments (Bottom View)

4-11. REFERENCE OSCILLATOR. (See figures 4-1 and 4-4.) Perform the reference oscillator adjustment as follows:

a. Set REF-RCV-COMP switch to REF; set OUTPUT switch to 30; and set ATTENUATOR control for DB readout of 60. Adjust GAIN control for convenient indication on OUTPUT meter.

b. Adjust L101 and L102 on reference oscillator box for maximum indication on OUTPUT meter.

NOTE

Adjustment of L101 may show a sharp drop in output to one side of maximum. If this occurs, set L101 for output slightly below maximum on the side opposite the sharp drop. This is a normal condition with crystal oscillators.

c. Adjust potentiometer R105 for 2.2 volts rms as measured at 30 MHz OUTPUT jack on rear panel. Note that voltage at attenuator is 2.35 volts rms due to transmission line effect in the cable from attenuator to output jack.

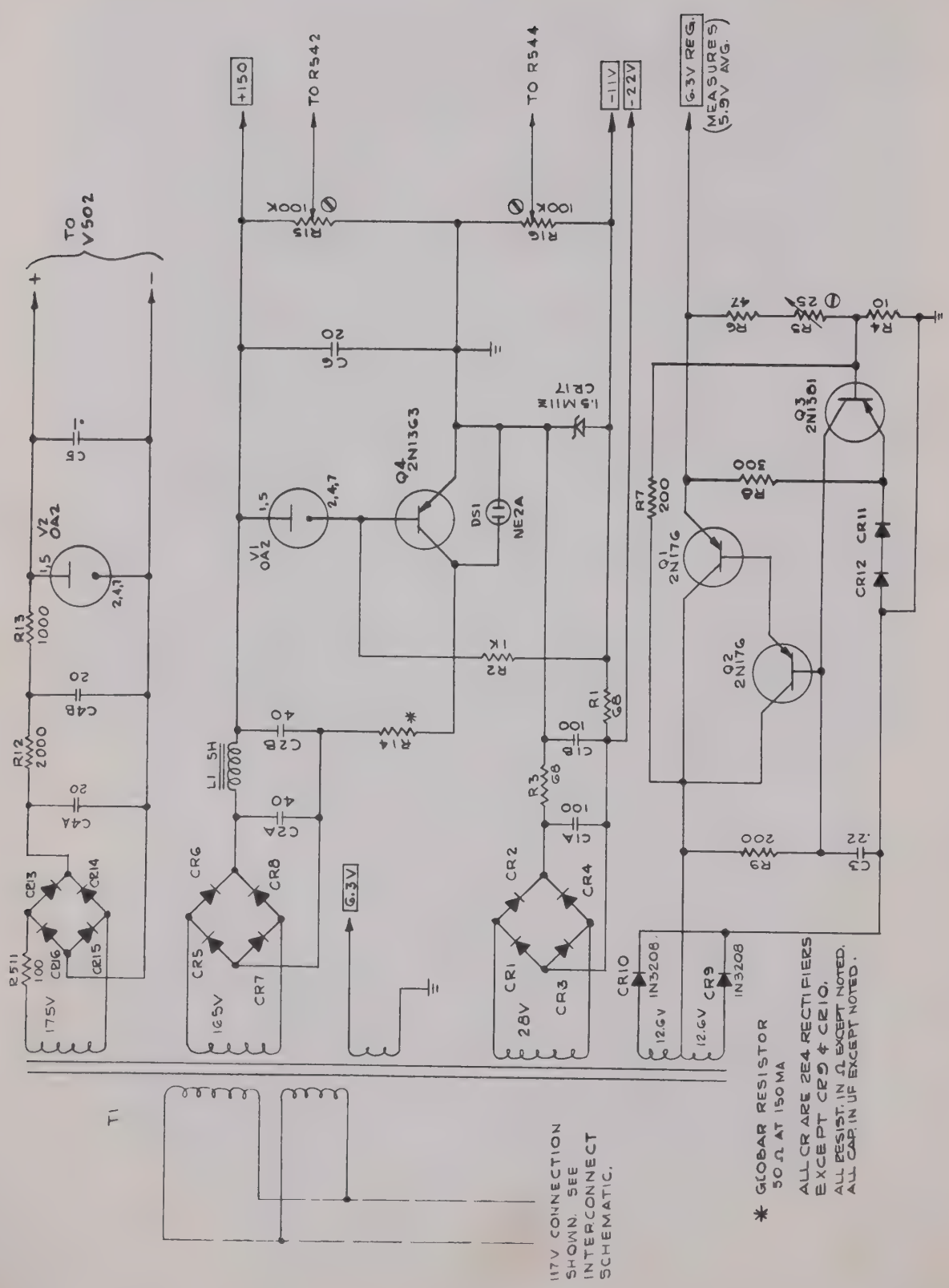


Figure 4-3. Power Supply, Schematic Diagram

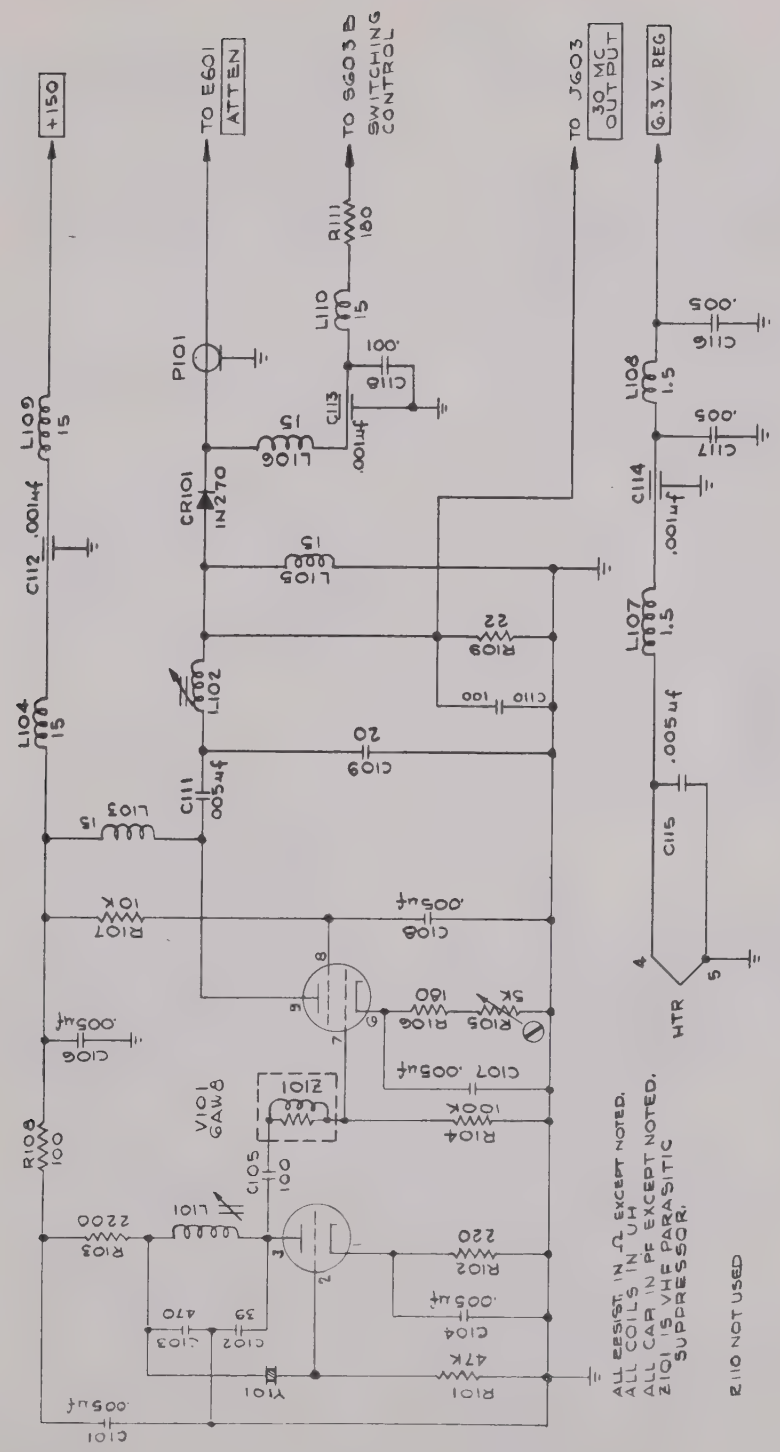


Figure 4-4. Reference Oscillator, Schematic Diagram

4-12. 1 KHz OSCILLATOR. (See figures 4-1, 4-2 and 4-5.) Perform the 1 KHz oscillator adjustment as follows:

a. Measure 1 KHz output voltage at top of potentiometer R311 (figure 4-2) and adjust potentiometer R306 (figure 4-1) on printed circuit board for 9.0 volts peak-to-peak (3.18 volts rms).

b. Check squarewave symmetry by observing output at 1 KHz OUT jack on rear panel.

c. With REF-RCV-COMP switch in COMP position, adjust ATTENUATOR for clean undistorted sinewave at pin 6 of V504 (figure 4-1). Adjust C318 (figure 4-2) for maximum amplitude. If necessary, readjust ATTENUATOR setting to prevent waveform distortion.

d. Synchronize oscilloscope from 1 KHz OUT jack and calibrate oscilloscope trace by observing squarewave at this point. Note position of crossovers on waveform and polarity.

e. Observe sinewave at pin 6 of V504 and adjust C318 so that sinewave crossovers match squarewave crossover points exactly.

4-13. Phase response of the tuned circuit Z501 varies with frequency, and slight frequency adjustment may be used to obtain exact phase matching between the i-f output signal and the reference signal to the phase detector. After proper adjustment, the audio oscillator frequency will be very close to the maximum response point of paragraph 4-12, step c. This adjustment is made with more convenience and precision using a dual-trace oscilloscope. The two signals may be displayed simultaneously and matched in phase with a minimum of error.

4-14. SQUAREWAVE SYMMETRY. (See figures 4-2 and 4-5.) Observe the squarewave at the 1 KHz OUT jack on the rear panel and adjust R311 for equal positive and negative periods. Audio oscillator output must be 9 volts peak-to-peak before making this adjustment.

4-15. OUTPUT VTVM CALIBRATION. (See figures 4-1 and 4-6.) Perform the output vtvm calibration as follows:

a. Set REF-RCV-COMP switch to REF; set OUTPUT switch to ZERO; and set XTAL-OUTPUT switch to OUTPUT. Adjust OUTPUT ZERO control on front panel for zero indication on OUTPUT meter.

b. Set OUTPUT switch to 1 and adjust GAIN control to maximum ccw position. Adjust ATTENUATOR control for 1.0 vdc output as measured with vtvm at rear panel DC VIDEO OUTPUT jack.

c. Adjust R527 (figure 4-1) for a 1-volt indication on OUTPUT meter.

4-16. AGC THRESHOLD ADJUSTMENT. (See figures 4-1 and 4-6.) Perform the AGC threshold adjustment as follows:

a. Set REF-RCV-COMP switch to COMP and set XTAL-OUTPUT switch to OUTPUT. Adjust ATTENUATOR control for maximum DB readout and adjust R526 (figure 4-1) until an indication is obtained on OUTPUT meter.

b. Adjust R526 until indication in step a just reaches zero.

NOTE

Some units may show a tendency toward oscillation (indicated by a periodic swing of the OUTPUT meter when a small signal is applied) with the adjustment as described. If this should occur, readjust R526 slightly until the AGC indication on the OUTPUT meter is slightly above zero or until the oscillation stops. When the adjustment is made properly, there will be no unstable conditions in the AGC.

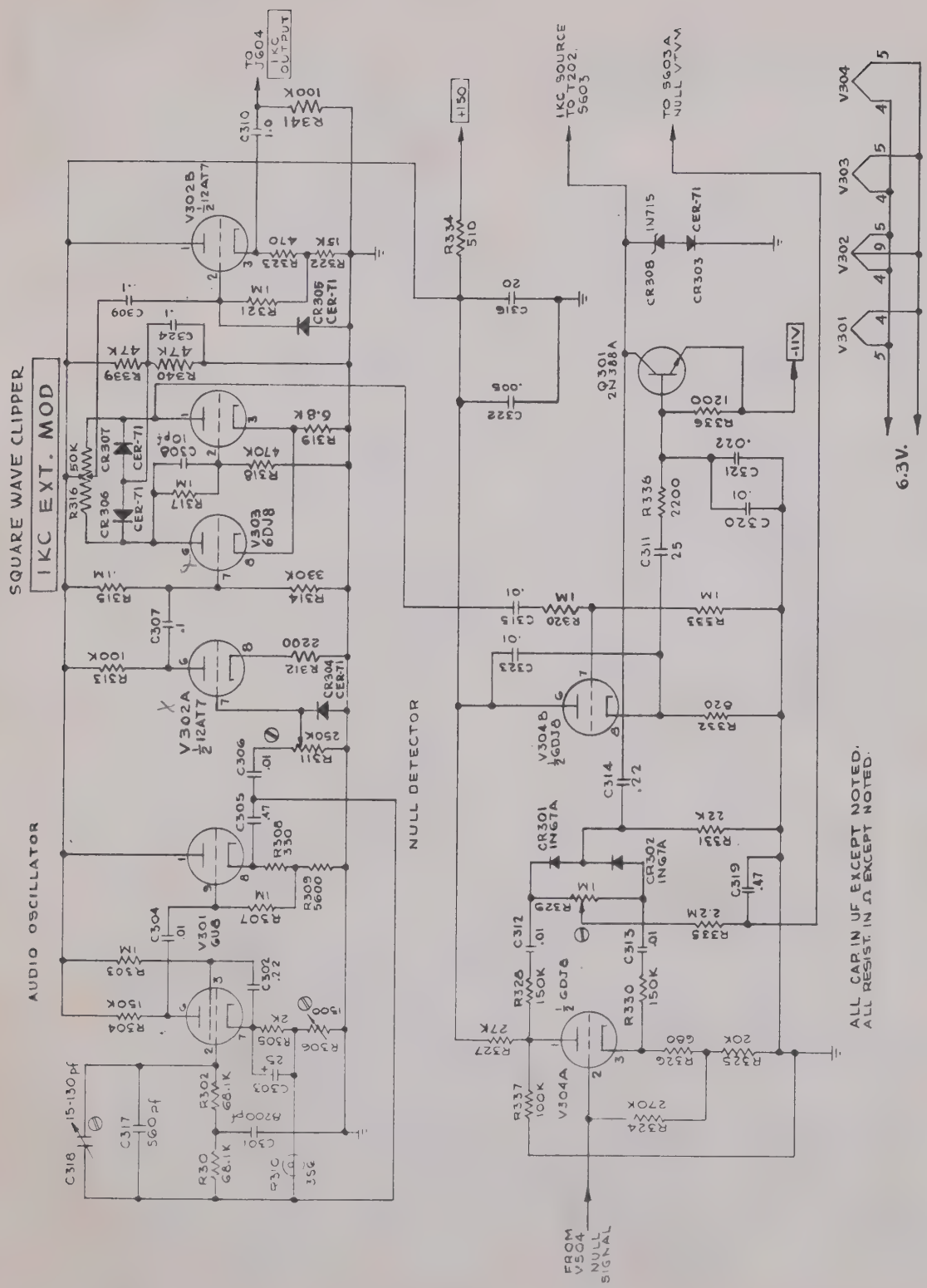


Figure 4-5. Audio Oscillator and Null Detector, Schematic Diagram

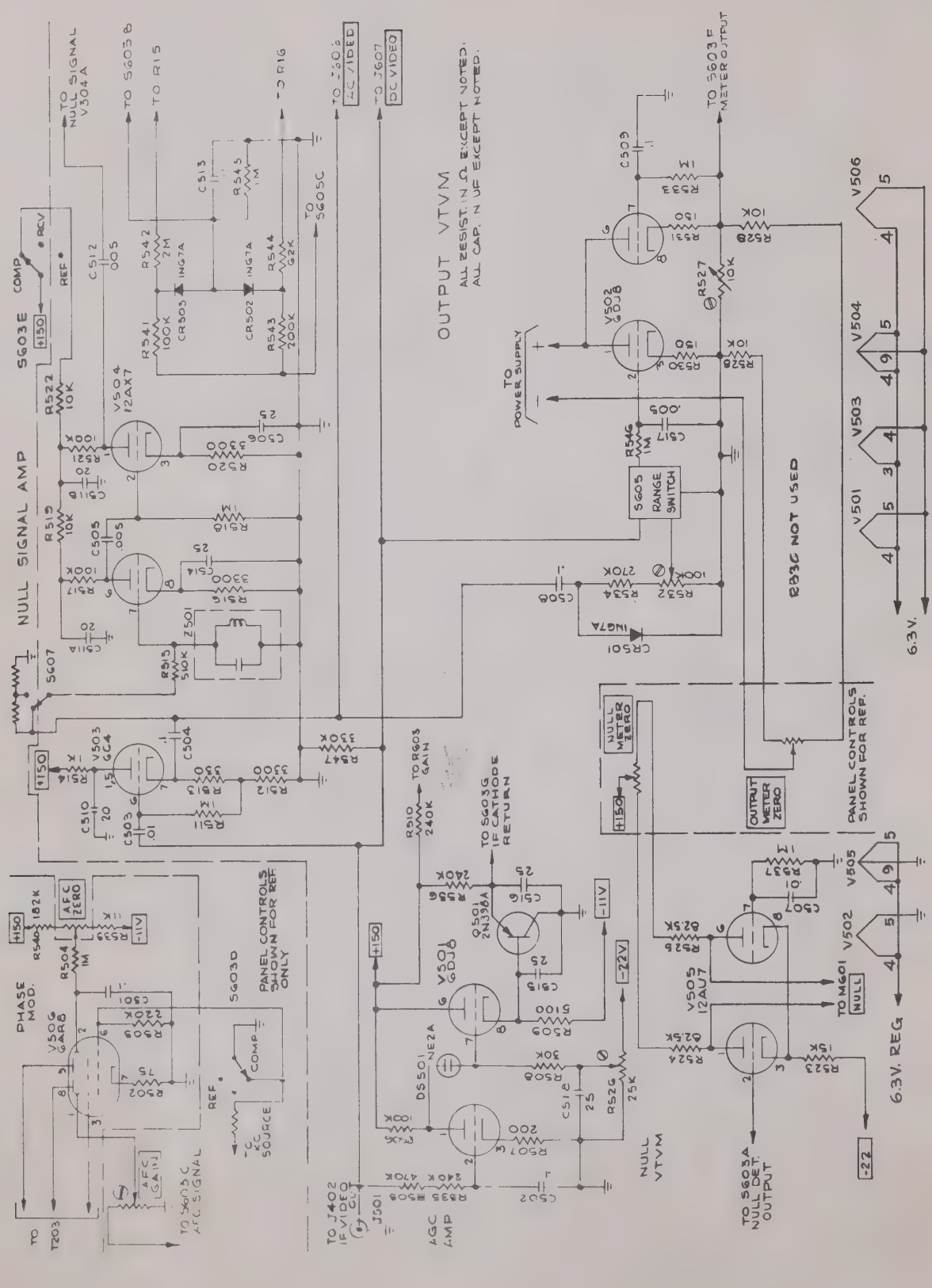


Figure 4-6. VTVM Deck, Schematic Diagram

4-17. AFC POWER SUPPLY ZERO ADJUSTMENT. (See figures 4-1 and 4-7.) Perform the AFC power supply zero adjustment as follows:

a. Set AFC switch to EXT position (either + or -) and set REF-RCV-COMP switch to COMP.

b. Adjust R209 (figure 4-1)on AFC deck for zero indication on FREQUENCY DEVIATION meter.

4-18. I-F STRIP ALIGNMENT. (See figures 4-1, 4-8 and 4-9.) This alignment procedures includes adjustment of the input switch (figure 4-9). A warm-up period of approximately 30 minutes should be allowed before adjustment. Warmup should be accomplished with the AFC switch in the EXT position (either + or -). Perform the alignment procedure as follows:

a. Terminate Receiver IN jack with 400 ohms shunted with 30 pf. Termination must be well-shielded to minimize external pickup.

b. Set REF-RCV-COMP switch to RCV; set GAIN control to maximum cw position; set OUTPUT switch to 3; set XTAL-OUTPUT switch to OUTPUT; and set ATTENUATOR control for maximum DB readout. Note indication due to noise on OUTPUT meter; noise level should be about 1.4 volts.

c. Set REF-RCV-COMP switch to REF and set OUTPUT switch to 10. Increase signal from reference oscillator by decreasing ATTENUATOR setting until OUTPUT meter indicates a video level of 7.0 volts.

d. Adjust L410, L408, L406, L404 and L402 (figure 4-1), in that order, for maximum indication on OUTPUT meter. Readjust ATTENUATOR setting if necessary to maintain video output at 7 volts on OUTPUT meter.

e. Repeat step d at least once.

f. While maintaining video output at 7 volts as indicated on OUTPUT meter, adjust L411 for maximum output as measured at test jack J404 (figure 4-1).

g. Set OUTPUT switch to 30. Increase input signal level by decreasing ATTENUATOR control setting until video output as indicated on OUTPUT meter reaches 30 volts. Adjust L412 until voltage at jack J403 reaches zero.

h. Remove 30 MHz signal by disconnecting cable at rear of attenuator housing. Readjust L411 for zero at jack J403. Adjust ATTENUATOR control for maximum DB readout and reconnect cable to rear of attenuator housing.

i. While monitoring voltage at jack J403 with vtvm and observing OUTPUT meter indication, gradually increase input signal by decreasing ATTENUATOR setting. Voltage at J403 will swing both positive and negative from zero point. If voltage swing, either polarity, exceeds 100 mv at any point before video output indicated on OUTPUT meter reaches 30 volts, L412 must be adjusted for a compromise, as indicated in steps j and k.

j. Adjust input signal to provide maximum swing at J403, but do not exceed 30 volts on OUTPUT meter. Adjust L412 to decrease voltage at J403 to 100 mv or less.

k. Repeat steps i and j to make certain that voltage swing does not exceed 100 mv. Positive and negative voltage swing should be approximately equalized when adjusting L412. If both positive and negative voltage swings exceed 100 mv, i-f strip must be realigned.

NOTE

Occasionally, 6AL6 tubes will be encountered which show a considerable offset between halves. With such tubes in the i-f strip discriminator, it may be extremely difficult to realize the proper adjustment. The tube may be detected by removing the limiter, V405, from its socket and noting the discriminator output voltage. If it exceeds 20 or 25 millivolts, replace the 6AL5 with one which is better balanced.

l. Set REF-RCV-COMP switch to REF and set OUTPUT switch to 30. Adjust ATTENUATOR control through its range; FREQUENCY DEVIATION meter indication may vary slowly from zero on either side by several divisions. This is normal and does not affect operation of the Receiver. Variation is caused by slight unbalance with level changes in discriminator diodes.

m. Set ATTENUATOR control for maximum DB readout and set AFC switch to INT (either + or -). Check NULL ZERO control adjustment and set REF-RCV-COMP switch to COMP. Adjust C702 accessible through hole at rear of input switch box (figure 4-2) for zero indication on NULL meter. Recheck this adjustment after null detector zero adjustment is performed (paragraph 4-19).

4-19. NULL DETECTOR ZERO ADJUSTMENT. (See figures 4-2 and 4-5.) Perform the null detector zero adjustment as follows:

a. Set REF-RCV-COMP switch to REF or RCV position; set X1-X10 switch to X1 and adjust NULL ZERO control for zero indication on NULL meter.

NOTE

For this procedure, the IN jack must be terminated by 400 ohms shunted with 35 pf as described in paragraph 4-18 step a.

b. Remove tube V101 from its socket. Set REF-RCV-COMP switch to COMP and set AFC switch to EXT (either + or -). Adjust R329 (figure 4-2) for zero indication on NULL meter.

c. Recheck null compensation adjustment by repeating step m of i-f strip alignment procedure in paragraph 4-18.

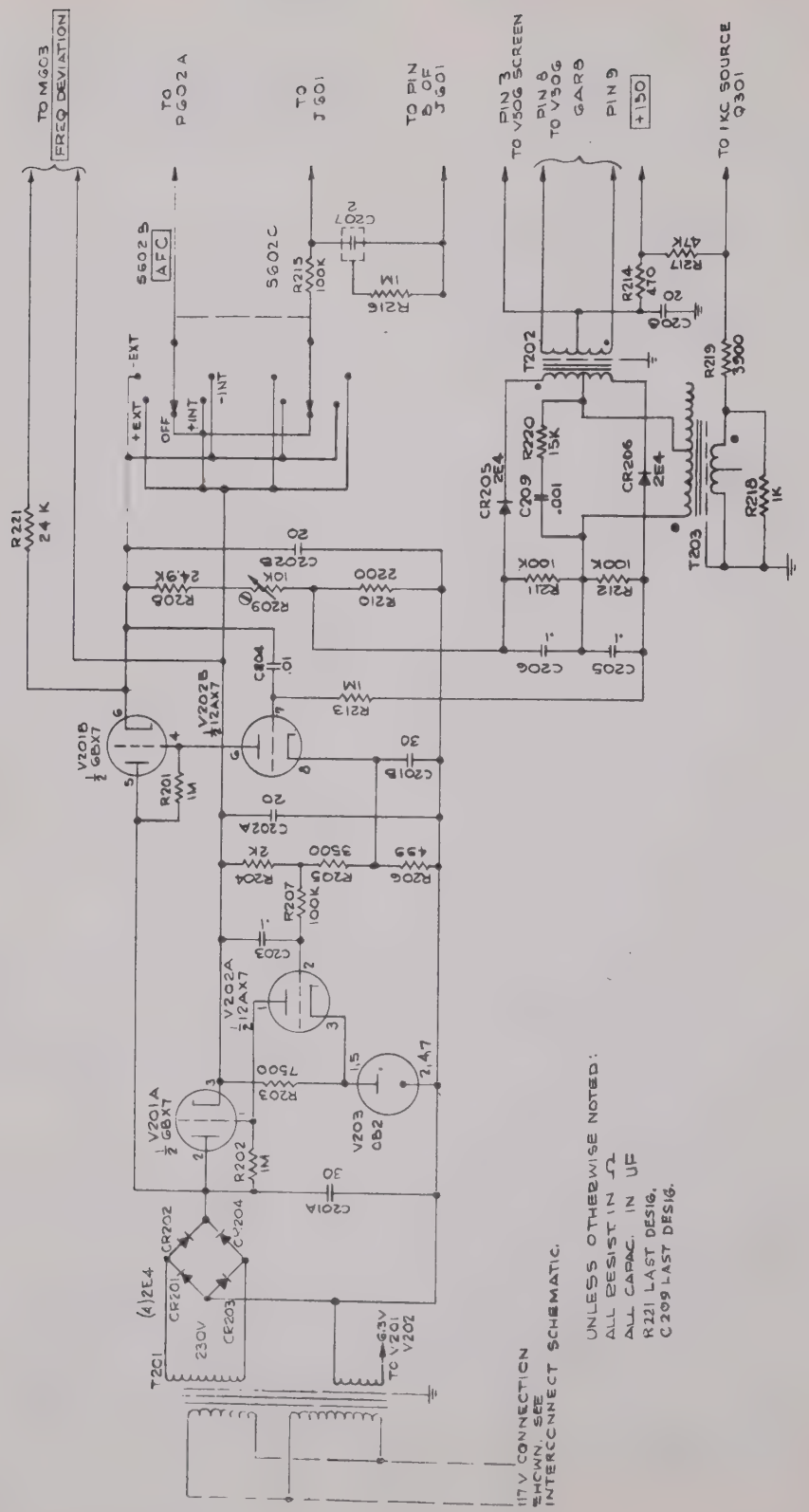


Figure 4-7. AFC Deck, Schematic Diagram

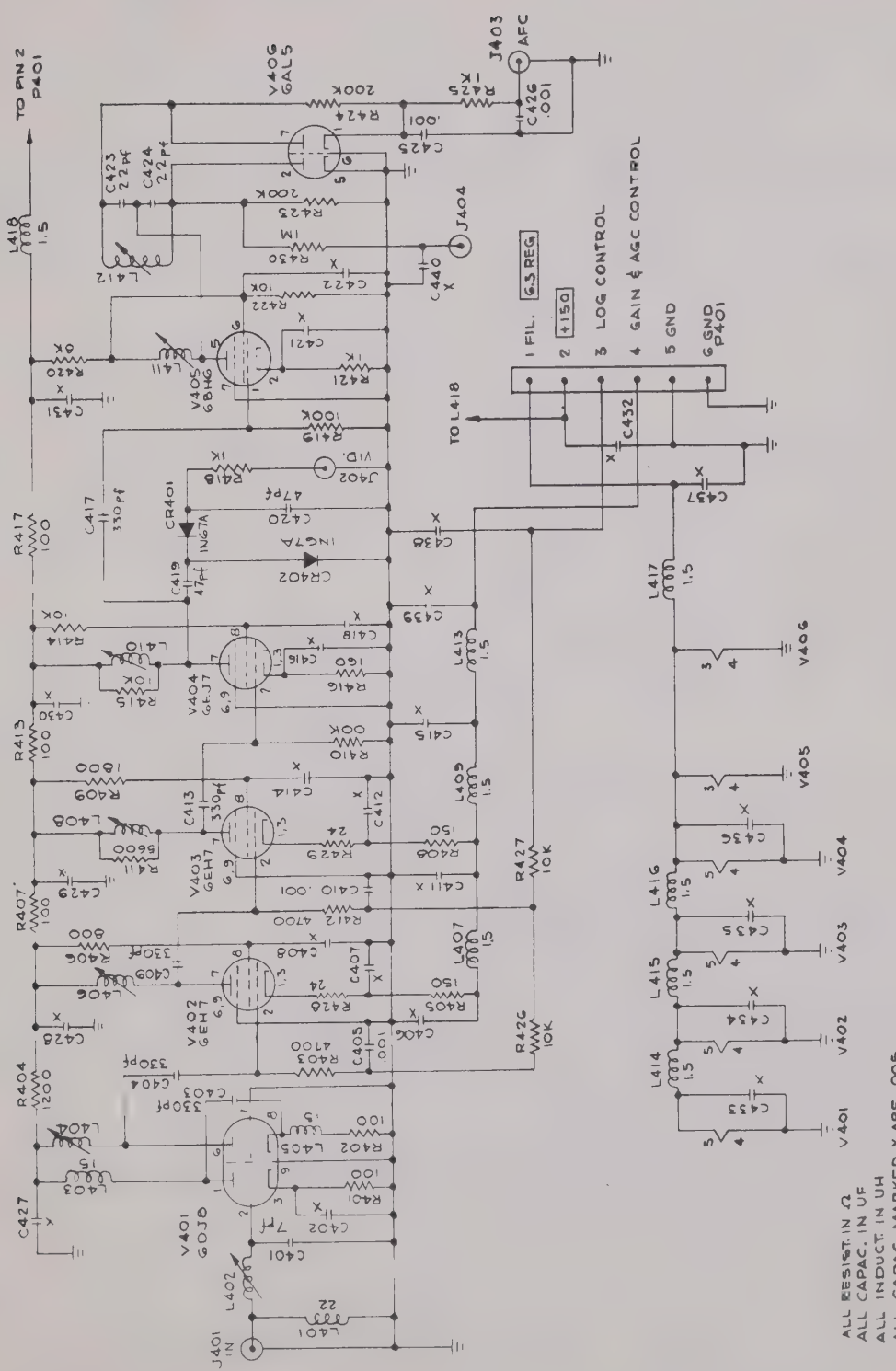


Figure 4-8. I-F Strip, Schematic Diagram

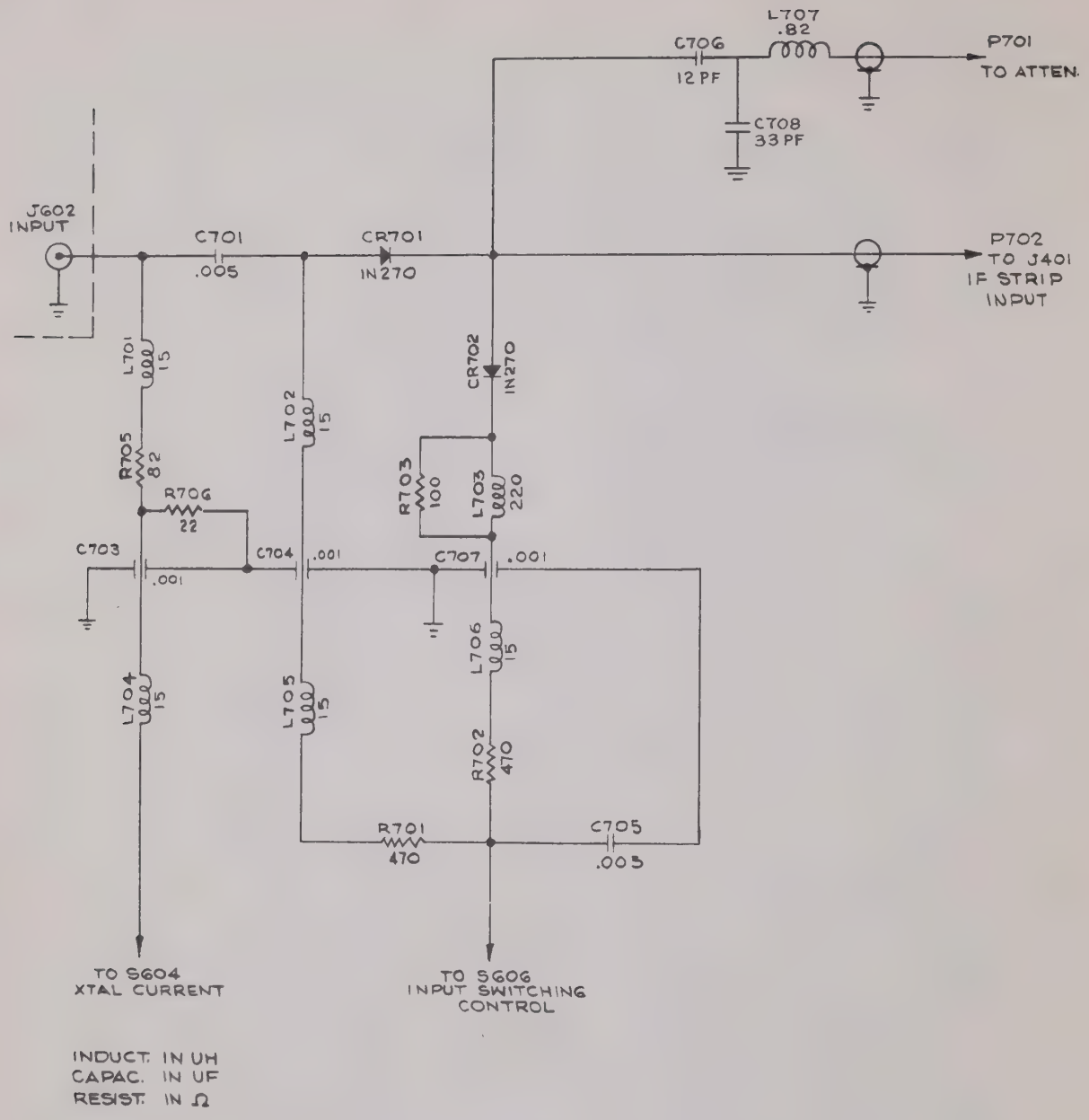


Figure 4-9. Input Switch, Schematic Diagram

4-20. LOG ADJUSTMENT. (See figures 4-1 and 4-3.) Perform the log adjustment as follows:

a. Set R15 in maximum cw position and set R16 in maximum ccw position.

b. Set OUTPUT switch to LOG position and apply a 30 MHz signal to IN jack on front panel. Adjust signal level for full scale indication on OUTPUT meter.

c. Reduce input signal level by 20 db. Adjust R15 for 20 db indication on OUTPUT meter.

d. Reduce input signal level to 50db below original level established in step b. Adjust R16 for 50 db indication on OUTPUT meter.

e. Repeat steps c and d several times to minimize interaction between the two adjustments.

4-21. CHECKING AC AMPLITUDE ON VTVM. (See figures 4-1 and 4-6.) AC amplitude is checked on VTVM as follows:

a. Set OUTPUT switch to AC position. Apply 10 volts rms, 1000 Hz to DC VIDEO OUTPUT jack on rear panel.

b. Adjust R532 for full scale indication on OUTPUT meter. Measure output at AC VIDEO jack on front panel with VTVM. Output should be approximately 8.0 volts.

4-22. ATTENUATOR MAINTENANCE AND ALIGNMENT. (See figure 4-10.) The Receiver incorporates a panel-mounted precision i-f attenuator, Narda Microline Model 46B1. The attenuator is designed and contructed to provide long life with minimum servicing. Each instrument is fully adjusted and accurately calibrated and no maintenance, except for lubrication of the gear sets, should be necessary; however should it become necessary to align the coplaner coils for maximum power transfer, proceed as follows:

a. Remove Receiver from case as outlined in Section II.

b. Remove control knobs from center plate of front panel and remove center plate.

c. Disconnect cables from attenuator.

d. Remove three screws securing attenuator to front panel and withdraw attenuator assembly from unit.

NOTE

Refer to figure 4-10 during the following steps.

e. Remove level gear (1) from 1/4-inch diameter rod.

f. Remove three socket-head screws and lockwashers (2) securing front casting assembly to body.

g. Remove front casting (3) without disturbing position of counter readout.

h. Loosen two screws (4) securing slotted endplate of coil assembly.

i. Connect output jack of attenuator for sensitive indicating system. Apply a 30 MHz signal to input jack of attenuator from a source having a characteristic impedance of 50 ohms, and rotate coil assembly for maximum output. (Position of red dot on end plate should be approximately 30 degrees in ccw direction from 1/4-inch diameter gear shaft.)

j. Reassemble attenuator using reverse of disassembly procedure.

4-23. Following alignment of coils, the insertion loss should be checked in the following manner: (See figure 4-10.)

a. Using sensitive attenuation measuring device, and with counter readout set at 000.00, an insertion loss of 23.1 $\pm$.1db is necessary in order to operate attenuator in linear region.

b. If insertion loss is other than 23.1 $\pm$.1 db, loosen universal joint (5) and rotate gear until correct reading is obtained.

c. Secure universal joint with counter set at 000.00 position.

4-24. If it becomes necessary to adjust attenuator backlash, proceed as follows: (See figure 4-10.)

a. Loosen set screw (6) holding the position-threaded collar.

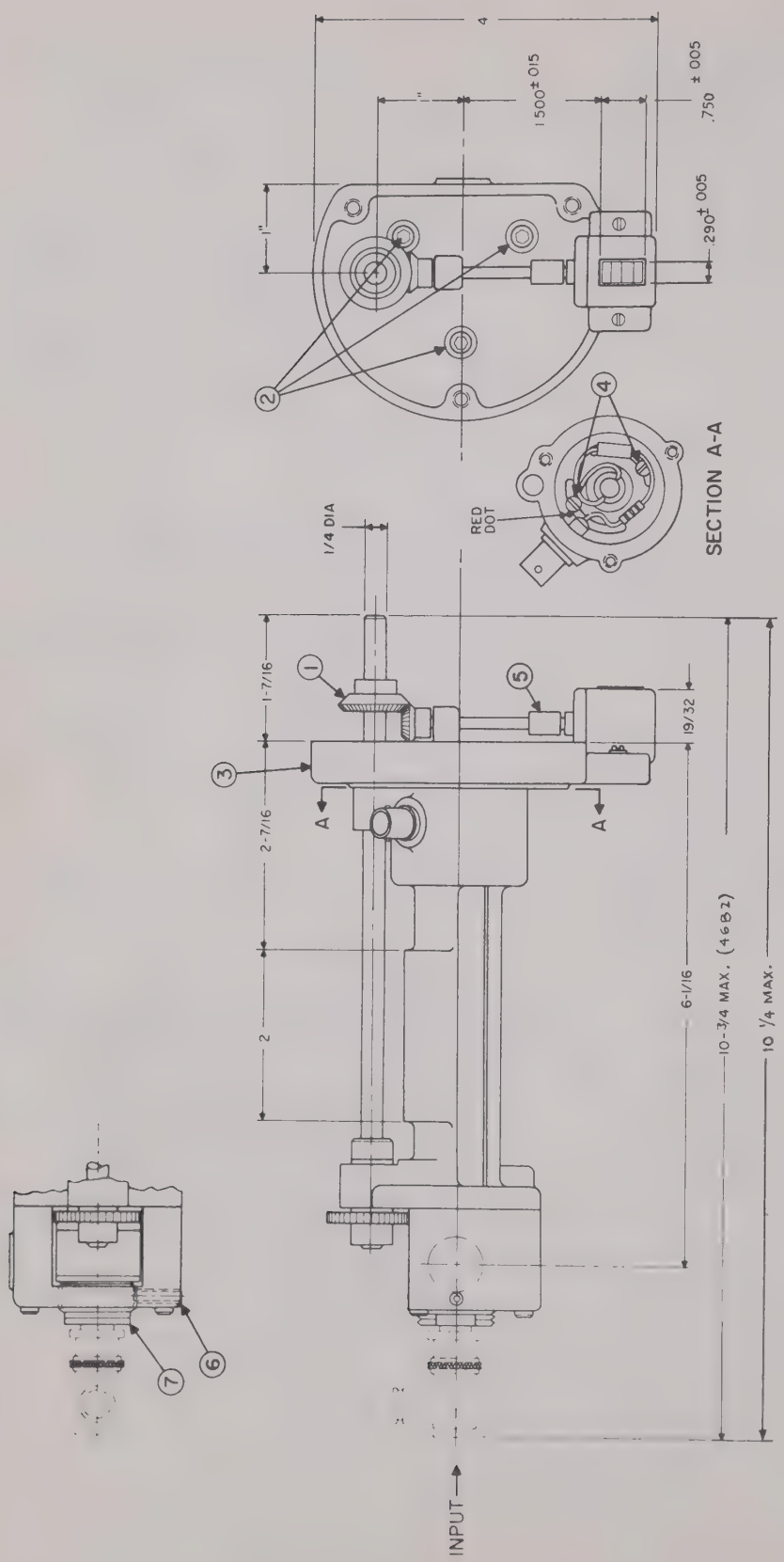
b. With 30 MHz source connected to attenuator input jack, and an extremely sensitive indicator system connected to the output, set a reference level and observe db reading on counter.

c. Turn attenuator drive shaft and reset counter to previously observed db reading.

d. Adjust threaded collar (7) on drive tube until indicator reference level is same as step b.

e. Turn attenuator drive shaft and reset to previously observed db reading in step a. If reference level deviates, repeat steps c and d until reference level repeats.

f. Tighten and glyptal setscrew (6) to hold position of threaded collar.



On later production units Attenuator 46B1 replaced by 46B2; Model 46B2 equipped with TNC connectors, and dimensions slightly larger.

Figure 4-10. Precision I-F Attenuator, Outline Dimensional Drawing

4-25. SWITCH FUNCTIONS

4-26. To aid in the maintenance of the Receiver, table 4-1 provides a listing of the OUTPUT and REF-RCV-COMP switch section functions, and is referenced to the Receiver interconnection diagram, figure 4-11.

4-27. REPAIR AND REPLACEMENT OF COMPONENTS

4-28. When replacing components in the Receiver, do not change ground points; relocation of ground points may tend to increase the Receiver noise level, thereby degrading the accuracy of low-level measurements. Dress leads and replacement parts in the same fashion as the original part to maintain original circuit balance and performance.

4-29. REPLACING MIXER CRYSTALS. When replacing mixer crystals, it may be necessary to select and match crystals to obtain good performance. Some crystals may possess an impedance which is too low and results in insufficient coupling. Some crystals may provide a poor noise figure which may limit the low level measurement capability; other crystals may have excessive conversion losses, causing a shift in the range of the Receiver. If a particular crystal exhibits any of these characteristics, try several other crystals before attempting realignment of the Receiver.

4-30. REPLACING I-F STRIP TUBES. If tubes in the i-f strip are replaced, it is recommended that tubes made by the manufacturers listed in the replaceable parts list (Section V) be used. This is particularly true of the input cascode tube. If tubes from another manufacturer are used, it may be necessary to select 6DJ8's to obtain the specified Receiver noise figure.

Table 4-1. Switch Functions

Switch Section	Function
OUTPUT switch:	
S605A	Switches multiplier on OUTPUT meter. Automatically sets voltmeter sensitivity in LOG position. Switches to ac rectifier in AC position.
S605B	Grounds i-f strip grid return in all positions except LOG; grounds cathode return in LOG.
S605C	Disconnects LOG network when not in LOG position.
REF-RCV-COMP switch:	
S603A	Connects null detector output to NULL meter in COMP position and grounds NULL meter input in RCV and REF positions.
S603B	Connects switching diodes to 1 KHz source in COMP; activates signal switch and turns off reference switch in RCV; turns on reference switch and biases signal switch off in REF.
S603C	In COMP position, removes short circuit across coupling capacitor and gives ac coupling in AFC signal to AFC phase modulator. In REF and RCV positions, coupling capacitor is bypassed, giving dc coupling.
S603D	Grounds signal grid of AFC phase modulator in COMP position; applies 1 KHz signal to signal grid in REF and RCV positions.
S603E	Applies +150 vdc to null signal amplifier in COMP position and removes +150 vdc in REF and RCV positions.
S603F	Connects OUTPUT meter to read AGC voltage in COMP position; connects OUTPUT meter to read output voltage in REF and RCV positions.
S603G	Switches i-f strip cathode return line to AGC line in COMP position; connects cathode return line to S605B in REF and RCV positions.
S603H	Connects i-f grid bias line to ground in COMP position; connects bias line to S605C in REF and RCV positions.

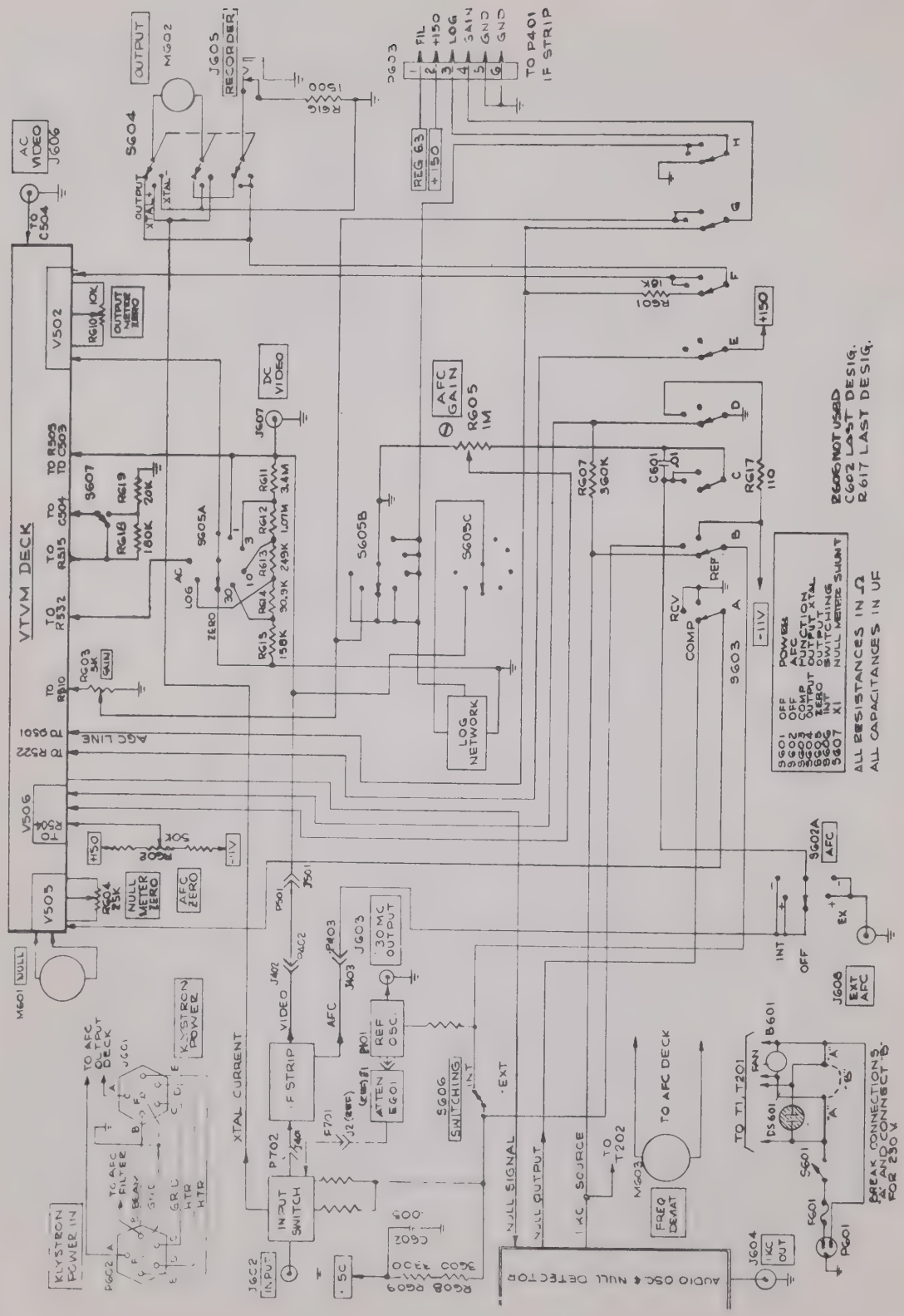


Figure 4-11. Receiver, Interconnection Diagram

Section V
Parts List

5-1. GENERAL

5-2. This section provides a listing of the replaceable parts of the Receiver. The listing contains the necessary information for the ordering of replacement parts. Parts are listed in alpha-numerical order of their reference designators in accordance with the designators assigned to these parts in the schematic diagrams included in Section IV of this manual. Part nomenclature, with descriptive data for ordering purposes, are provided along with the Narda part number of each part.

5-3. To facilitate ordering of a replacement, parts are referenced to the selected list of manufacturers. (See table 5-1.) A manufacturer's code number is included in the parts list for this purpose. The total quantity of each part installed in the Receiver is also shown in the parts list. The replaceable parts list is presented in table 5-2.

5-4. ORDERING INFORMATION

5-5. If it is desired to order replacement parts from the instrument manufacturer, address the order to:

SALES DEPARTMENT
The Narda Microwave Corporation
Plainview, L.I., New York

5-6. When ordering a part in this manner, the following information should be provided.

a. Model and serial number of the instrument.
b. Narda part number.
c. Reference designation.
d. Description.

5-7. When ordering a part not listed in table 5-2, a complete description of the part, including its function and location, should be provided with the model and serial number of the instrument.

5-8. CUSTOMER REPAIR SERVICE

5-9. Repairs or recalibration of Narda Microline products are performed by the Customer Service Department at the factory; however, before returning any instrument, contact the Narda Microwave Corporation or the Narda Sales Representative in the area for shipping instructions. When requesting maintenance, complete the from provided at the rear of this manual.

Table 5-1. Manufacturer's Code

A Aerovox Corp. New Bedford, Mass.	I Amperite Co. New York, N. Y.	Q Bussman Mfg. Co. St. Louis, Mo.
B Amperex Electronics Corp. Hicksville, N. Y.	J Astron Corp. East Newark, N. J.	R Birnbach Radio Co. New York, N. Y.
C Allen-Bradley Co. Milwaukee, Wis.	K All Star Products, Inc. Defiance, Ohio	S Sperry Microwave Electronics Co. Clearwater, Fla.
D Aemco, Inc. Mankato, Minn.	L Any brand tube meeting EIA standards	T Clarostat Mfg. Co. Dover, N. H.
E Arrow, Hart and Hegeman Hartford, Conn.	M Beede Electrical Instrument Co. Penacook, N. H.	U Chicago Telephone Supply Elkhart, Ind.
F Advance Electric & Relay Co. Burbank, Calif.	N Belden Mfg. Co. Chicago, Ill.	V Centralab Div. Globe Union, Inc. Milwaukee, Wis.
G Alcon Metal Products, Inc. Chicago, Ill.	O Bud Radio, Inc. Cleveland, Ohio	W Cinch-Jones Mfg. Co. Chicago, Ill.
H Amphenol Electronics Corp. Chicago, Ill.	P Barber-Colman Co. Rockford, Ill.	X Corning Glass Works Bradford, Pa.

Table 5-1. Manufacturer's Code (continued)

Y	California Resistor Corp. Santa Monica, Calif.	AS	E. F. Johnson Co. Waseca, Minn.	bm	Sprague Electric Co. North Adams, Mass.
Z	Cornell-Dubilier Electric Co. So. Plainfield, N. J.	AT	James Millen Mfg. Co., Inc. Malden, Mass.	BN	Superior Electric Co. Bristol, Conn.
AA	Dage Electric Co., Inc. Beech Grove, Ind.	AU	Kulka Electric Mfg. Co., Inc. Mount Vernon, N. Y.	BO	Sylvania Electric Emporium, Pa.
AB	Dial Light Co. of America Brooklyn, N. Y.	AV	Kelvin Electric Co. Van Nuys, Calif.	BP	Switchcraft, Inc. Chicago, Ill.
AC	Dale Products, Inc. Columbus, Neb.	AW	Line Electric Co. Newark, N. J.	BQ	Herman H. Smith, Inc. Brooklyn, N. Y.
AD	Hugh H. Eby Co. Philadelphia, Pa.	AX	Littelfuse, Inc. Des Plaines, Ill.	BR	Synchro Corp. Hicksville, Ohio
AE	Erie Resistor Corp. Erie, Pa.	AY	M. E. C. Nashville, Tenn.	BS	Sloan Co. Burbank, Calif.
AF	Essex Electronics, Inc. Berkeley Heights, N. J.	AZ	J. W. Miller Co. Los Angeles, Calif.	BT	Triad Transformer Co. Huntington, Ind.
AG	Electro Motive Mfg. Co. Willimantic, Conn.	BA	Motorola, Inc. Phoenix, Ariz.	BU	Tepro of Florida, Inc. Dunedin, Fla.
AH	Electra Mfg. Co. Kansas City, Mo.	BC	North American Electronics, Inc. Lynn, Mass.	BV	Texas Instruments, Inc. (T. I.) Dallas, Texas
AI	General Electric Co. Owensboro, Ky.	BD	Oak Mfg. Co. Chicago, Ill.	BW	Transformer Technician, Inc. Chicago, Ill.
AJ	Florida Transformer Co. De Leon Springs, Fla.	BE	Ortho Industries Paterson, N. J.	BX	Tung-Sol Electric, Inc. Newark, N. J.
AK	Gremar Mfg. Co. Wakefield, Mass.	BF	Potter and Brumfield, Inc. Princeton, Ind.	BY	Unimax Switch Division Wallingford, Conn.
AL	Hammarlund Mfg. Co., Inc. New York, N. Y.	BG	Plastic Capacitors, Inc. Chicago, Ill.	BZ	Veeder Root, Inc. Hartford, Conn.
AM	Heyman Mfg. Co. Kenilworth, N. J.	BH	Peterson Radio Co. Council Bluffs, Ia.	CA	Winchester Electronics, Inc. Santa Monica, Calif.
AN	Hi-Q Div. of Aerovox Corp. Myrtle Beach, S. C.	BI	Philco Corp. Lansdale, Pa.	CB	Walsco Rockford, Ill.
AO	IEI Nashville, Tenn.	BJ	Raytheon Mfg. Co. Newton, Mass.	CC	Workman TV Sarasota, Fla.
AP	Industrial Devices, Inc. Edgewater, N. J.	BK	Radio Materials Co. (R. M. C.) Chicago, Ill.	CD	United International Dynamics Waltham, Mass.
AQ	International Rectifier Corp. El Segundo, Calif.	BL	R. C. A. Tube Division Harrison, N. J.	CE	The Muter Co. Chicago, Ill.
AR	International Resistance Co. (IRC) St. Petersburg, Fla.	BM	Radio Receptor Co., Inc. Brooklyn, N. Y.	CF	Columbus Electronics Yonkers, N. Y.

Table 5-2. Replaceable Parts List

Reference Designation	Description	Mfr. Code	Narda Part No.	Quantity Per Unit
B601	Fan	P	A-01900-2	1
C1	Capacitor: 100/100 uf, -10% +100%, 50 wvdc	A	C-02235-207	1
C2	Capacitor: 40/40 uf, -10% +100%, 250 wvdc	A	C-02235-208	1
C3	Capacitor: 0.22 uf, 20%, 200 wvdc	A	A-01202-207	2
C4	Capacitor: 20/20 uf, -10% +100%, 250 wvdc	A	C-02235-201	1
C5	Capacitor: 0.1 uf, 20%, 200 wvdc	A	A-01202-205	8
C6	Capacitor: 20 uf, -10%, +100%, 250 wvdc	A	A-01230-7	4
C101	Capacitor: 0.005 uf, +80% -20%, 500 wvdc	BK	A-01210-005	42
C102	Capacitor: 39 pf, 5%, 300 wvdc	A	80111-013	1
C103	Capacitor: 470 pf, 5%, 300 wvdc	A	80111-039	1
C104	Same as C101			
C105	Capacitor: 100 pf, 10% 600 wvdc	V	A-01205-101	1
C106	Same as C101			
C107	Same as C101			
C108	Same as C101			
C109	Capacitor: 20 pf, 5%, 300 wvdc	A	80111-006	1
C110	Capacitor: 100 pf, 5%, 300 wvdc	A	80111-023	1
C111	Same as C101			
C112	Capacitor: 0.001 uf, 20%, 500 wvdc	V	A-01260-102	6
C113	Same as C112			
C114	Same as C112			
C115	Same as C101			
C116	Same as C101			
C117	Same as C101			
C118	Capacitor: 0.001 uf, GMV, 500 wvdc	BK	A-01210-001	6
C201	Capacitor: 30/30 uf, -10% +100%, 350 wvdc	A	A-01236-5	1
C202	Capacitor: 20/20 uf, -10% +100%, 250 wvdc	A	A-01236-1	2
C203	Same as C5			
C204	Capacitor: 0.01 uf, +8-%, -20%, 500 wvdc	BK	A-01210-010	12
C205	Capacitor: .1 uf, +80% -20%, 100 wvdc	A	A-01212-100	2
C206	Same as C205			
C207	Capacitor: 2 uf, +20% -10%, 1000 wvdc	A	A-01217-102	1
C208	Same as C6			
C209	Same as C118			
C301	Capacitor: 820 pf, 5%, 300 wvdc	A	015-23	1
C302	Capacitor: .22 uf, 20%, 200 wvdc	bm	#2 SE-P22	3
C303	Capacitor: 25 uf, -10% +100%, 25 wvdc	A	VL-1210	2
C304	Same as C204			
C305	Capacitor: 0.47 uf, 20%, 200 wvdc	bm	#2 SE-P47	2
C306	Same as C204			
C307	Capacitor: .1 uf, 20%, 500 wvdc	bm	#5 GA-P10	3
C308	Capacitor: 10 pf, 10%, 600 wvdc	V	A-01205-100	1
C309	Same as C307			
C310	Capacitor: 1uf, 200 wvdc	bm	#155 P10502	1
C311	Same as C303			
C312	Same as C204			
C313	Same as C204			
C314	Same as C302			
C315	Same as C204			
C316	Same as C6			
C317	Capacitor: 560 pf, 5%, 300 wvdc	A	80108-049	1
C318	Capacitor: Var, 15-130 pf, 250 wvdc	AG	A-01240-1	1
C319	Same as C305			
C320	Same as C204			
C321	Same as C302			
C322	Same as C101			
C323	Same as C204			
C324	Same as C307			
C401	Capacitor: 7 pf, 100%, 500 wvdc	A	80115-006	1
C402	Same as C101			

Table 5-2. Replaceable Parts List (continued)

Reference Designation	Description	Mfr. Code	Narda Part No.	Quantity Per Unit
C403	Capacitor: 330 pf, 10%, 600 wvdc	V	A-01205-331	6
C404	Same as C403			
C405	Same as C118			
C406	Same as C101			
C407	Same as C101			
C408	Same as C101			
C409	Same as C403			
C410	Same as C118			
C411	Same as C101			
C412	Same as C101			
C413	Same as C403			
C414	Same as C101			
C415	Same as C101			
C416	Same as C101			
C417	Same as C403			
C418	Same as C101			
C419	Capacitor: 47 pf, 5%, 300 wvdc	A	80111-015	2
C420	Same as C419			
C421	Same as C101			
C422	Same as C101			
C423	Capacitor: 22 pf, 5%, 300 wvdc	A	80111-007	2
C424	Same as C423			
C425	Same as C118			
C426	Same as C118			
C427	Same as C101			
C428	Same as C101			
C429	Same as C101			
C430	Same as C101			
C431	Same as C101			
C432	Same as C101			
C433	Same as C101			
C434	Same as C101			
C435	Same as C101			
C436	Same as C101			
C437	Same as C101			
C438	Same as C101			
C439	Same as C101			
C440	Same as C101			
C501	Same as C5			
C502	Same as C5			
C503	Same as C204			
C504	Same as C5			
C505	Same as C101			
C506	Capacitor: .25 uf, +250% -10%, 25 wvdc	A	A-01230-2	5
C507	Same as C204			
C508	Same as C5			
C509	Same as C5			
C510	Same as C6			
C511	Same as C202			
C512	Same as C101			
C513	Same as C5			
C514	Same as C506			
C515	Same as C506			
C516	Same as C506			
C517	Same as C101			
C518	Same as C506			
C601	Same as C204			
C602	Same as C101			

Table 5-2. Replaceable Parts List (continued)

Reference Designation	Description	Mfr. Code	Narda Part No.	Quantity Per Unit
C701	Same as C101			
C702	Not Used			
C703	Same as C112			
C704	Same as C112			
C705	Same as C101			
C706	Capacitor: 12 pf, 50%, 500 wvdc	V	80115-009	1
C707	Same as C112			
C708	Capacitor: 33 pf, 5%, 500 wvdc	V	80115-017	1
CR1	Rectifier: CER-71	AQ	A-01952	25
CR2	Same as CR1			
CR3	Same as CR1			
CR4	Same as CR1			
CR5	Same as CR1			
CR6	Same as CR1			
CR7	Same as CR1			
CR8	Same as CR1			
CR9	Rectifier: 1N3208	BA	A-1953-051	2
CR10	Same as CR9			
CR11	Same as CR1			
CR12	Same as CR1			
CR13	Same as CR1			
CR14	Same as CR1			
CR15	Same as CR1			
CR16	Same as CR1			
CR17	Diode: Zener, 1.5 MHz	BA	A-01959-1	1
CR101	Diode: 1N270	BM	A-01950-2	3
CR201	Same as CR1			
CR202	Same as CR1			
CR203	Same as CR1			
CR204	Same as CR1			
CR205	Same as CR1			
CR206	Same as CR1			
CR301	Diode: 1N67A	BM	A-01950-1	7
CR302	Same as CR301			
CR303	Same as CR1			
CR304	Same as CR1			
CR305	Same as CR1			
CR306	Same as CR1			
CR307	Same as CR1			
CR308	Diode: Zener, 1N715	BA	A-01959-2	1
CR401	Same as CR301			
CR402	Same as CR301			
CR501	Same as CR301			
CR502	Same as CR301			
CR503	Same as CR301			
CR701	Same as CR101			
CR702	Same as CR101			
DS1	Bulb: Neon NE2A	BX	A-01852-3	2
DS501	Same as DS1			
DS601	Lamp: Neon	AP	A-02850-1	1
F601	Fuse: 2 amp, 125 v	Q	A-01790-2	1
J401	Connector: BNC, UG-1094	AA	A-01752	1
J402	Connector: Phono Jack	BP	A-01729-1	3
J403	Same as J402			
J404	Connector: Test Jack	AS	A-1720-1	1
J501	Same as J402			
J601	Connector	CA	A-1740-1	1
J602	Connector: BNC, UG-912/U	AA	A-1754-4	2

Table 5-2. Replaceable Parts List (continued)

Reference Designation	Description	Mfr. Code	Narda Part No.	Quantity Per Unit
J603	Connector: BNC, UG-290A/U	AA	603306	1
J604	Connector: BNC, UG-625	AK	A-01751	3
J605	Connector: Phone Jack	BP	A-01731-2	1
J606	Same as J602			
J607	Same as J604			
J608	Same as J604			
J609	Connector: Bulkhead Jack, UG-909/U	AA	A-01754-2	1
L1	Choke: 5 H	AJ	C-02461	1
L101	Coil: Var, .65 ±10% uh	AZ	C-02486-1	1
L102	Coil: Var, 1.0 ±10% uh	AZ	C-02486-4	1
L103	Coil: 15 uh	AZ	C-02475-156	13
L104	Same as L103			
L105	Same as L103			
L106	Same as L103			
L107	Coil: 1.5 uh	AF	C-02476-157	10
L108	Same as L107			
L109	Same as L103			
L110	Same as L103			
L401	Coil: 22 uh	AZ	C-02475-226	1
L402	Coil: Var, 1.20-1.80 uh	AZ	C-02486-2	1
L403	Same as L103			
L404	Coil: Var, 1.0-1.60 uh	AZ	C-02486-5	5
L405	Same as L103			
L406	Same as L404			
L407	Same as L107			
L408	Same as L404			
L409	Same as L107			
L410	Same as L404			
L411	Same as L404			
L412	Coil: Var, 1.60-2.80 uh	AZ	C-02486-6	1
L413	Same as L107			
L414	Same as L107			
L415	Same as L107			
L416	Same as L107			
L417	Same as L107			
L418	Same as L107			
L701	Same as L103			
L702	Same as L103			
L703	Coil: 220 uh	AZ	9210-92	1
L704	Same as L103			
L705	Same as L103			
L706	Same as L103			
M601	Meter: (Null)	M	B-02508	1
M602	Meter: (Output)	M	C-02507	1
M603	Meter: (Freq. Dev.)	M	C-02510	1
P101	Connector: BNC Plug, UG-88/U	AA	A-01750-1	1
P401	Connector	W	A-01728-206	1
P501	Connector: Phono Plug	BP	A-01729-2	1
P601	Connector: Plug	N	A-01700-2	1
P602	Connector: Plug	CA	A-1740-2	1
P603	Connector: Plug	W	A-01728-106	1
P701	Connector: BNC UG-913	AA	A-1750-7	1
P702	Connector: BNC Angle Plug	AA	A-1750-8	1
Q1	Transistor: 2N176	BA	A-01961	2
Q2	Same as Q1			
Q3	Transistor: 2N1381	BV	A-01962	2
Q4	Transistor: 2N1363	BA	A-01963-1	1
Q301	Transistor: 2N388A	BV	A-01964-8	1

Table 5-2. Replaceable Parts List (continued)

Reference Designation	Description	Mfr. Code	Narda Part No.	Quantity Per Unit
Q501	Transistor: 2N398A	BV	A-01964-7	1
R1	Resistor, Fixed, Composition: 2 w, 68 ohms, ±5%	C	83011-021	2
R2	Resistor, Fixed, Composition: 1 w, 1 k, ±5%	C	83014-049	2
R3	Same as R1			
R4	Resistor, Fixed, Composition: 1 w, 10 ohms, ±5%	C	83014-001	1
R5	Resistor, Var, Wire Wound: 1 1/2 w, 25 ohms, ±20%	U	A-01186-250	1
R6	Resistor, Fixed, Composition: 1 w, 47 ohms, ±5%	C	83014-017	1
R7	Resistor, Fixed, Composition: 1/2 w, 200 ohms, ±5%	C	83010-032	3
R8	Resistor, Fixed, Composition: 1/2 w, 300 ohms, ±5%	C	83010-036	1
R9	Same as R7			
R10	Resistor, Fixed, Composition: 1/2 w, 100 ohms, ±5%	C	83010-025	6
R11	Not Used			
R12	Resistor, Wirewound, Power: 5 w, 2000 ohms, ±5%	T	A-01110-202	1
R13	Resistor, Wirewound, Power: 5 w, 1000 ohms, ±5%	T	A-01110-102	1
R14	Resistor, Thermistor, Globar: 150 ma, 50 ohms	CC	A-01140-1	1
R15	Resistor, Var, Composition: 1/4 w, 100 k, ±30%	U	A-01151-104	3
R16	Same as R15			
R101	Resistor, Fixed, Composition: 1/2 w, 47 k, ±5%	C	83010-089	5
R102	Resistor, Fixed, Composition: 1/2 w, 220 ohms, ±5%	C	83010-033	1
R103	Resistor, Fixed, Composition: 1/2 w, 2200 ohms, ±5%	C	83010-057	3
R104	Resistor, Fixed, Composition: 1/2 w	C	83010-097	14
R105	Resistor, (Pot) Var, Carbon: 2 w, 5 k, ±20%	U	A-01170-502	1
R106	Resistor, Fixed, Composition: 1/2 w, 180 ohms, ±5%	C	83010-031	1
R107	Resistor, Fixed, Composition: 1/2 w, 10 k, ±5%	C	83010-073	7
R108	Same as R10			
R109	Resistor, Fixed, Composition: 1/2 w, 22 ohms, ±5%	C	83010-009	2
R110	Not Used			
R111	Resistor, Fixed, Composition: 2 w, 180 ohms, ±5%	C	83011-031	1
R201	Resistor, Fixed, Composition: 1/2 w, 1 Meg, ±5%	C	83010-121	17
R202	Same as R201			
R203	Resistor, Fixed, Composition: 2 w, 7500 ohms, ±5%	C	83011-070	1
R204	Resistor, Wirewound, Power: 5 w, 2 k, ±5%	T	A-01110-202	1
R205	Resistor, Wirewound, Power: 5 w, 3500 ohms, ±5%	T	A-01110-352	1
R206	Resistor, Dep. Carbon: 1 w, 499 ohms, ±1%	AC	A-01116-268	1
R207	Same as R104			
R208	Resistor, Dep. Carbon: 1 w, 24.9 k, ±1%	AC	A-01116-439	1
R209	Resistor, Var, Wirewound: 2 w, 10 k, ±10%	U	A-01189-103	1
R210	Resistor, Fixed, Composition: 1 w, 2200 ohms, ±5%	C	83014-057	1
R211	Same as R104			
R212	Same as R104			
R213	Same as R201			
R214	Resistor, Fixed, Composition: 1 w, 470 ohms, ±5%	C	83014-041	1
R215	Same as R104			
R216	Same as R201			
R217	Same as R101			
R218	Resistor, Fixed, Composition: 1/2 w, 1 k, ±5%	C	83010-049	4
R219	Resistor, Fixed, Composition: 1/2 w, 3900 ohms, ±5%	C	83010-063	1
R220	Resistor, Fixed, Composition: 1/2 w, 15 k, ±5%	C	83010-077	2
R221	Resistor, Fixed, Composition: 1 2, 24 k, ±5%	C	83014-082	1
R301	Resistor, Dep. Carbon: 1/2 w, 68.1 k, ±1%	AC	A-01115-481	2
R302	Same as R301			
R303	Same as R201			
R304	Resistor, Fixed, Composition: 1/2 w, 150 k, ±5%	C	83010-101	3
R305	Resistor, Fixed, Composition: 1/2 w, 2 k, ±5%	C	83010-056	1
R306	Resistor, Var, Wirewound: 1 1/2 w, 1500 ohms, ±20%	U	A-01186-152	1
R307	Same as R201			
R308	Resistor, Fixed, Composition: 1/2 w, 330 ohms, ±5%	C	83010-037	2
R309	Resistor, Fixed, Composition: 1/2 w, 5600 ohms, ±5%	C	83010-067	2

Table 5-2. Replaceable Parts List (continued)

Reference Designation	Description	Mfr. Code	Narda Part No.	Quantity Per Unit
R310	Resistor (Bulb, Type 3S6): 3 w, 117 v	BX	A-01852-4	1
R311	Resistor (Pot) Var, Composition: 1/4 w, 250 k, ±30%	U	A-01151-254	1
R312	Same as R103			
R313	Same as R104			
R314	Resistor, Fixed, Composition: 1/2 w, 470 k, ±5%	C	83010-113	3
R315	Resistor, Fixed, Composition: 1/2 w, 1.1 Meg, ±5%	C	83010-122	1
R316	Same as R101			
R317	Same as R201			
R318	Same as R314			
R319	Resistor, Fixed, Composition: 1 w, 6.8 k, ±5%	C	83014-069	2
R320	Resistor, Fixed, Composition: 1/2 w, 22 k, ±5%	C	83010-081	2
R321	Same as R201			
R322	Resistor, Fixed, Composition: 1/2 w, 15 k, ±5%	C	83010-077	1
R323	Resistor, Fixed, Composition: 1/2 w, 470 ohms, ±5%	C	83010-041	3
R324	Resistor, Fixed, Composition: 1/2 w, 270 k, ±5%	C	83010-107	2
R325	Resistor, Fixed, Composition: 1/2 w, 20 k, ±5%	C	83010-080	2
R326	Resistor, Fixed, Composition: 1/2 w, 680 ohms, ±5%	C	83010-045	1
R327	Resistor, Fixed, Composition: 1/2 w, 27 k, ±5%	C	83010-083	1
R328	Same as R304			
R329	Resistor, (Pot) Var, Carbon: 2 w, 100 k, ±20%	U	A-01171-105	1
R330	Same as R304			
R331	Same as R320			
R332	Resistor, Fixed, Composition: 1/2 w, 820 ohms, ±5%	C	83010-047	1
R333	Same as R201			
R334	Resistor, Fixed, Composition: 2 w, 510 ohms, ±5%	C	83011-042	1
R335	Resistor, Fixed, Composition: 1/2 w, 2.2 Meg, ±5%	C	83010-129	1
R336	Resistor, Fixed, Composition: 1/2 w, 1200 ohms, ±5%	C	83010-051	1
R337	Same as R104			
R338	Same as R103			
R339	Same as R101			
R340	Same as R101			
R341	Same as R104			
R401	Same as R10			
R402	Same as R10			
R403	Resistor, Fixed, Composition: 1/2 w, 4700 ohms, ±5%	C	83010-065	3
R404	Resistor, Fixed, Composition: 2 w, 1200 ohms, ±5%	C	83011-051	1
R405	Resistor, Fixed, Composition: 1/2 w, 150 ohms, ±5%	C	83010-029	3
R406	Resistor, Fixed, Composition: 1/2 w, 1800 ohms, ±5%	C	83010-055	2
R407	Same as R10			
R408	Same as R405			
R409	Same as R406			
R410	Same as R104			
R411	Same as R309			
R412	Same as R403			
R413	Same as R10			
R414	Same as R107			
R415	Same as R107			
R416	Resistor, Fixed, Composition: 1/2 w, 160 ohms, ±5%	C	83010-030	1
R417	Resistor, Fixed, Composition: 1 w, 100 ohms, ±5%	C	83014-025	1
R418	Same as R218			
R419	Same as R104			
R420	Resistor, Fixed, Composition: 1 w, 18 k, ±5%	C	83014-079	1
R421	Same as R218			
R422	Resistor, Fixed, Composition: 1 w, 10 k, ±5%	C	83014-073	2
R423	Resistor, Fixed, Composition: 1/2 w, 200 k, ±5%	C	83010-104	3
R424	Same as R423			
R425	Same as R218			
R426	Same as R107			

Table 5-2. Replaceable Parts List (continued)

Reference Designation	Description	Mfr. Code	Narda Part No.	Quantity Per Unit
R427	Same as R107			
R428	Resistor, Fixed, Composition: 1/2 w, 24 ohms, ±5%	C	83010-010	2
R429	Same as R428			
R430	Same as R201			
R501	Not Used			
R502	Resistor, Fixed, Composition: 1/2 w, 75 ohms, ±5%	C	83010-022	1
R503	Resistor, Fixed, Composition: 1/2 w, 220 k, ±5%	C	83010-105	1
R504	Same as R201			
R505	Same as R314			
R506	Same as R104			
R507	Same as R7			
R508	Resistor, Fixed, Composition: 1/2 w, 30 k, ±5%	C	83010-084	1
R509	Resistor, Fixed, Composition: 1/2 w, 5100 ohms, ±5%	C	83010-066	1
R510	Resistor, Fixed, Composition: 1/2 w, 240 k, ±5%	C	83010-106	3
R511	Same as R201			
R512	Resistor, Fixed, Composition: 1 w, 3300 ohms, ±5%	C	83014-061	1
R513	Same as R308			
R514	Same as R2			
R515	Resistor, Fixed, Composition: 1/2 w, 510 k, ±5%	C	83010-114	1
R516	Resistor, Fixed, Composition: 1/2 w, 3300 ohms, ±5%	C	83010-061	2
R517	Same as R104			
R518	Same as R201			
R519	Same as R422			
R520	Same as R516			
R521	Same as R104			
R522	Same as R422			
R523	Same as R220			
R524	Resistor, Dep. Carbon: 1/2 w, 82.5 k, ±1%	AC	A-01115-489	2
R525	Same as R524			
R526	Resistor, (Pot), Var, Composition: 1/3 w, 25 k, ±30%	U	A-01151-253	1
R527	Resistor, (Pot), Var, Composition: 1/2 w, 10 k, ±30%	U	A-01151-103	1
R528	Same as R107			
R529	Same as R107			
R530	Same as R405			
R531	Same as R405			
R532	Same as R15			
R533	Same as R201			
R534	Same as R324			
R535	Same as R510			
R536	Same as R510			
R537	Same as R201			
R538	Not Used			
R539	Resistor, Dep. Carbon: 1/2 w, 11 k, ±1%	AC	A-01115-405	1
R540	Resistor, Dep. Carbon: 1/2 w, 182 k, ±1%	AC	A-01115-526	1
R541	Same as R104			
R542	Resistor, Fixed, Composition: 1/2 w, 100 k, ±5%	C	83010-128	1
R543	Same as R423			
R544	Resistor, Fixed, Composition: 1/2 w, 62 k, ±5%	C	83010-092	1
R545	Same as R201			
R546	Same as R201			
R547	Resistor, Fixed, Composition: 1/2 w, 330 k, ±5%	C	83010-109	1
R601	Resistor, Fixed, Composition: 1/2 w, 18 k, ±5%	C	83010-079	1
R602	Resistor, (Pot), Var, Composition: 1/3 w, 50 k, ±30%	U	A-01179-503	1
R603	Resistor, (Pot), Var, Wirewound: 2 w, 5 k, ±10%	U	A-01185-502	1
R604	Resistor, (Pot), Var, Composition: 1/3 w, 25 k, ±30%	U	A-01152-253	1
R605	Resistor, (Pot), Var, Composition: 1/4 w, 1 Meg, ±30%	U	A-01151-105	1
R606	Not Used			
R607	Resistor, Fixed, Composition: 1/2 w, 360 k, ±5%	C	83010-110	1

Table 5-2. Replaceable Parts List (continued)

Reference Designation	Description	Mfr. Code	Narda Part No.	Quantity Per Unit
R608	Resistor, Fixed, Composition: 2 w, 3600 ohms, ±5%	C	83011-062	1
R609	Resistor, Fixed, Composition: 2 w, 3300 ohms, ±5%	C	83011-061	1
R610	Resistor, (Pot), Var, Composition: 1/2 w, 10 k, ±30%	U	A-01152-103	1
R611	Resistor, Dep. Carbon: 1/2 w, 3.4 Meg, ±1%	AC	A-01115-652	1
R612	Resistor, Dep. Carbon: 1/2 w, 1.07 Meg, ±1%	AC	A-01115-604	1
R613	Resistor, Dep. Carbon: 1/2 w, 249 k, ±1%	AC	A-01115-539	1
R614	Resistor, Dep. Carbon: 1/2 w, 90.0 k, ±1%	AC	A-01115-493	1
R615	Resistor, Dep. Carbon: 1/2 w, 158 k, ±1%	AC	A-01115-520	1
R616	Resistor, Fixed, Composition: 1/2 w, 1500 ohms, ±5%	C	83010-053	1
R617	Resistor, Fixed, Composition: 2 w, 110 ohms, ±5%	C	83011-026	1
R618	Resistor, Fixed, Composition: 1/2 w, 180 k, ±5%	C	83010-103	1
R619	Same as R325			
R701	Same as R323			
R702	Same as R323			
R703	Resistor, Fixed, Composition: 1/2 w, 100 ohms, ±5%	C	83010-025	1
R704	Not Used			
R705	Resistor, Fixed, Composition: 1/2 w, 82 ohms, ±5%	C	83010-023	1
R706	Same as R109			
S601	Switch, Toggle, SPST	E	A-01650-1	2
S602	Switch, Rotary, Non Shorting, 5 Positions Each Section	BD	B-02664-2	1
S603	Switch, Rotary, 3 Positions Each Section, 4 Sections, 3 Non Shorting, 1 Shorting	BD	B-02665-2	1
S604	Switch, Rotary, 3 Positions, 2 Sections, 1 Section Non Shorting, 1 Shorting	BD	B-02666-1	1
S605	Switch, Rotary, 7 Positions, 3 Sections, 1 Section Non Shorting, 2 Shorting	BD	B-02667-2	1
S606	Same as S601			
S607	Switch, Slide, Non Shorting, SPDT	CD	A-01659-112	1
T1	Transformer	AJ	D-02412	1
T201	Transformer	AJ	D-02413	1
T202	Transformer	AJ	C-02417	2
T203	Same as T202			
V1	Tube, Electron: Type OA2	L	A-01001	2
V2	Same as V1			
V101	Tube, Electron: Type 6AW8A	L	A-01025	1
V201	Tube, Electron: Type 6BX7	L	A-01033	1
V202	Tube, Electron: Type 12AX7	L	A-01065	2
V203	Tube, Electron: Type OB2	L	A-01003	1
V301	Tube, Electron: Type 6U8	L	A-01057	1
V302	Tube, Electron: Type 12AT7	L	A-01063	1
V303	Tube, Electron: Type 6DJ8	B	A-01044	5
V304	Same as V303			
V401	Same as V304			
V402	Tube, Electron: Type 6EH7	B	A-01047	2
V403	Same as V402			
V404	Tube, Electron: Type 6EJ7	B	A-01048	1
V405	Tube, Electron: Type 6BH6	L	A-01028	1
V406	Tube, Electron: Type 6AL5	L	A-01019	1
V501	Same as V303			
V502	Same as V303			
V503	Tube, Electron: Type 6C4	L	A-01035	1
V504	Same as V202			
V505	Tube, Electron: Type 12AU7	L	A-01064	1
V506	Tube, Electron: Type 6AR8	L	A-01022	1
Y101	Crystal: 30 MHz	BH	C-02910	1
Z101	Choke: VHF Parasitic Suppressor	S	C-02478-1	1
Z501	Tuned Circuit: 5 ma, 10 v	BE	B-02480-1	1

narda *Microline*

THE NARDA MICROWAVE CORPORATION PLAINVIEW, L.I., NEW YORK 11803

516 - 433 - 9000

REQUEST FOR MAINTENANCE

FROM:

COMPANY _____ DATE _____

ADDRESS _____ NAME _____

_____ TITLE _____

DIVISION _____ TELEPHONE _____ EXT_____

_____

EQUIPMENT _____

MODEL _____ SER _____

REASON FOR REQUEST:

☐ Recalibration

☐ Unit not functioning properly

If for repair, describe trouble _____

_____

_____

_____

_____

_____

Is trouble localized? _____

If so, how and where? _____

_____

_____

_____

_____

_____

_____

_____

Is trouble intermittent? _____

Approximate hours of operation prior to failure _____

Date of failure _____

Was factory consulted by telephone or letter prior to this request? _____

If so, give date and name of person to whom directed _____

_____

_____

Additional Comments: _____

_____

_____

_____

_____

_____

_____

_____

When failure occurs requiring factory assistance, complete this form and send to:

The Narda Microwave Corporation
Plainview, L. I., New York 11803
ATTENTION: CUSTOMER SERVICE DEPARTMENT

After this request has been reviewed by the Customer Service Department, you will be contacted by the Company or the Sales Representative in your area. If it is required to ship the equipment back to the factory, we will notify you with instructions and authorization for returning the equipment.

NO EQUIPMENT MAY BE RETURNED TO THE FACTORY WITHOUT WRITTEN AUTHORIZATION.